BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78 NO. 4, PP. 289–291 JULY, 1951

A NEW ORCHID FROM THE SOUTHERN APPALACHIANS

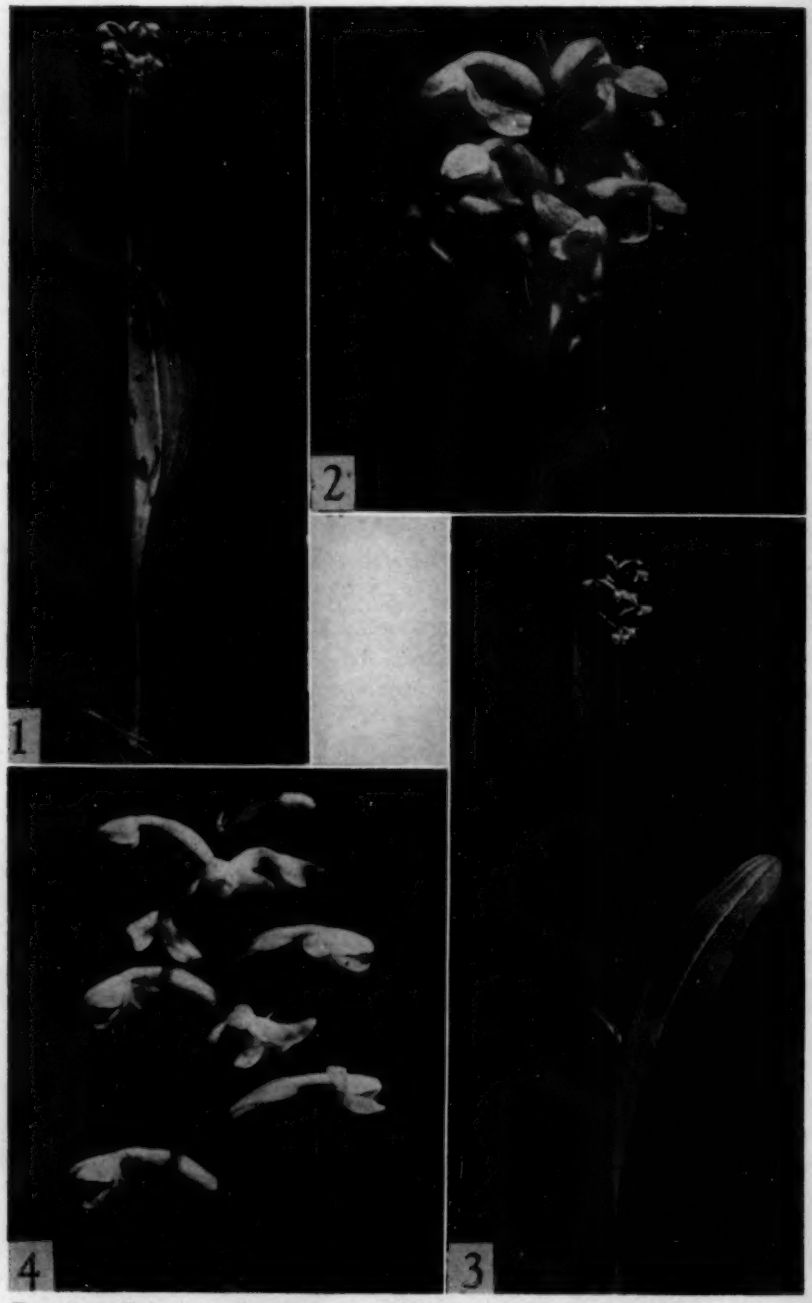
LINDSAY S. OLIVE

During the summer of 1949, while the writer and Mr. Henry Wright, native botanist of Highlands, North Carolina, were on a field trip in the Highlands area, an orchid which appears not to have been previously described was found. The orchid in its general appearance greatly resembled the common Green Rein-orchid, *Habenaria clavellata* (Michx.) Spreng., the specific name of which refers to the elongate club-like spur, 8–12 mm. in length, produced by the flower. Only a few plants were in bloom at the time, but all of the flowers that were found completely lacked the spur. A few plants were dug up and set out on the writer's lot at Highlands, and two of them bloomed the following year. The flowers again failed to produce spurs. Another field trip was arranged at this time to the area previously visited, and a large number of plants were found in bloom. All had the same characteristics as the plants observed the previous summer. They closely resembled *H. clavellata,* but none of the flowers had produced spurs (figs. 1–4). Although the Green Rein-orchid was found in bloom at the same time several miles from this area, no plant of that species was encountered in this locality.

The unidentified orchid had become well established in the area, and probably several hundred plants were present over a half acre or more of moist woods composed mainly of hemlock, rhododendron, and deciduous trees. Other orchids found growing here were *Goodyera pubescens* (Willd.) R. Br. (Downy Rattlesnake Plantain), *Triphora trianthophora* (Sw.) Rydb. (Nodding Pogonia), and a sterile plant of *Habenaria ciliaris* (L.) R. Br. (Yellow Fringed Orchid). Plants of the unidentified orchid were growing on both sides of a small stream, and a few were found on the opposite side of a small dirt road running through the area. These circumstances indicate that the orchid reproduces itself mainly by means of seeds. Correll (1950), in his recent comprehensive monograph of the orchids of North America, has no record of the orchid described in this paper. However, in his discussion of *Habenaria clavellata,* he points out that this species is self-pollinated; "so it usually produces a maximum of fully ripened seed-filled capsules which thus assure it of perpetuation." This also appears to be true of the Highlands plant.

With regard to *H. clavellata,* Ames (1910) states that it is "a very distinct species with no near ally in North America. The appendages of the gynostemium are quite characteristic. These are three in number, erect and

[THE BULLETIN for May–June, (78: 183–288) was issued May 14, 1951]



FIGS. 1–4. *Habenaria clavellata* var. *Wrightii*. FIGS. 1, 3. Mature flowering plants. × ½. FIGS. 2, 4. Enlarged racemes of the same plants. × 2.2.

tuberculate." The new orchid has a similar structure; that is, there are three tuberculate stigma-lobes as in *H. clavellata*. In addition to the failure to produce a spur, the flower of the new plant shows only one distinctive difference from that of *H. clavellata*. The lip, instead of being tridentate, is entire and almost acuminate. In its other characteristics the plant so closely resembles the Green Rein-orchid that it has seemed advisable to describe it as a variety of that species. Dr. E. J. Alexander of the New York Botanical Garden has also expressed the opinion that this orchid is a new variety of *H. clavellata*. Thus an orchid lacking flower spurs is placed in a genus which has as one of its chief characteristics the production of flower spurs.

HABENARIA CLAVELLATA var. **Wrightii** var. nov. *Habenariae clavellatae* similis, sed flos calcar caret, et petalum inferius est integrum, fere acuminatum, interdum sinuosum.

Plants about 20–30 cm. tall; roots elongate, fleshy; stem angled, with several bract-like leaves above and one oblanceolate leaf arising from near the base. Racemes few- to many-flowered, 1.5–3 cm. long; floral bracts lanceolate-acuminate, as long as or nearly as long as the ovaries. Flowers small, about 1 cm. in length, greenish white, the upper sepal and two petals ovate, remaining grouped together, the two lateral sepals elliptic or ovate-elliptic, becoming reflexed in the fully opened flower, lower petal or lip somewhat elliptic, entire, nearly acuminate or with slightly blunt tip, sometimes irregularly and inconspicuously sinuate distally along the margins. Spur completely lacking. Stamen one, anther single, 2-celled, one pollinium in each cell; pollinium with caudicle attached to a viscid basal disc. Stigma divided into three blunt papillose lobes, one lobe on each side of the anther and the middle one between the two anther cells. Ovary ridged, somewhat spirally twisted; ovules numerous, minute, on three parietal placentae in the 1-celled ovary.

Collected in Blue Valley, elevation about 2500 feet, near Highlands, North Carolina; August 2, 1950.

The Latin description was prepared by Dr. D. P. Rogers. A type specimen of the new variety has been deposited in the herbarium of the New York Botanical Garden.

These investigations were performed at the Highlands Biological Laboratory.

DEPARTMENT OF BOTANY, COLUMBIA UNIVERSITY
NEW YORK, N. Y.

Literature Cited

Ames, O. 1910. Orchidaceae, fasc. 4 (The genus *Habenaria* in North America.)
Correll, D. S. 1950. Native Orchids of North America. Waltham.

CORRECTION: New or noteworthy species of Tremellales from the Southern Appalachians. By Lindsay S. Olive. (Bull. Torrey Club 78: 103–112. 1951). On pages 105 and 107 for: *Helicogloea augustispora*, read: *Helicogloea angustispora*.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, PP. 292–299 JULY, 1951

CHROMOSOME NUMBERS OF SOME TEXAS GRASSES

WALTER V. BROWN

This is a second report on the chromosome numbers of native and introduced grasses. The first report (Brown, 1950) concerned the chromosome numbers of eighty species in thirty-eight genera of nine tribes of the Gramineae. The present is the result of a cytological study of forty-four species (all but two additional to the first report) in twenty-four genera of five tribes. As in the previous paper identification and nomenclature of all United States grasses are according to Hitchcock (1935), Herbarium specimens have been made of parts of the plants studied and are filed in the University of Texas Herbarium. Many of the plants are growing in the grass garden of the Plant Research Institute.

Materials and methods. Root tips of the grasses were either collected in the field or from potted plants after a period of growth in the greenhouse. After fixation in the CRAF modification of Navashin's fluid the root tips were embedded and sectioned according to standard procedures. Since nearly all species studied have small chromosomes, cross sections were cut at 8 or 10 microns. In order to have permanent slides Heidenhain's iron alum hemotoxylin was used for the stain. For studies of meiosis young inflorescences were fixed in absolute-acetic fixative and smeared in aceto-carmine.

Table 1 lists the species studied, the author's collection numbers, the chromosome numbers found and the authority for those species previously studied. In a few cases plants were furnished by the U. S. Soil Conservation Service Station at San Antonio, Texas and their numbers are used and are designated by letter prefixes. References to previous records of chromosome numbers in Table 1 are usually the latest, if more than one exists, unless there are conflicting chromosome numbers reported. The listing of $2n$ numbers indicates that counts were derived from a study of metaphase chromosomes of mitosis in root tips. The listing of n numbers indicate that the counts were made in a study of diakinesis of the first meiotic division in pollen mother cells.

Results and discussion. Many of these reported chromosome counts require little or no comment aside from their being on record whereas others, of more significance, are discussed at greater length.

Festuceae. The seeds and herbarium specimen of *Festuca arizonica* were collected at the Manitou Experimental Forest of the U. S. Department of Agriculture, Forest Service near Colorado Springs, Colorado. The plants were grown in the greenhouse and proved to be hexaploid with 42 large

TABLE 1. *Chromosome numbers in the Gramineae*

Genus and Species	Collection No.	Fig.	*n*	*2n*	Previous Records	
					2n	Authority
FESTUCEAE						
Festuca arizonica Vasey	3512	1	—	42		
Distichlis texana (Vasey) Scribn.	3516	2	—	40		
Eragrostis curtipedicellata Buckl.	3374	3	—	40		
CHLORIDEAE						
Leptochloa virgata (L.) Beauv.	3488	4	—	40	40	(Nunez in Parodi 1946)
Chloris virgata Swartz	3273	5	10	—	20	(Brown 1950)
Trichloris pleuriflora Fourn.	T-33	6	—	60		
Bouteloua hirsuta Lag.	3261	7	—	28	21, 37, 42	(Fults 1942)
AGROSTIDEAE						
Lycurus phleoides H.B.K.	3309	8	—	28		
Sporobolus poiretii (R. and S.) Hitch.	3264	9	—	36	36	(Avdulow 1931)
S. airoides (Torr.) Torr.	SA-4031	10	54	—	126	(Stebbins and Love 1941)
Piptochaetium fimbriatum (H.B.K.) Hitchc.	3326	11	—	44		
Stipa leucotricha Trin and Rupr.	3473	12	—	26	26	(Brown 1949)
S. tenuissima Trin.	3305	13	—	32		
S. eminens Cav.	3302	14	—	46	46	(Love, in Myers 1947)
Muhlenbergia porteri Scribn.	3349	15	—	20		
M. polycaulis Scribn.	3329	16	—	20		
M. monticola Buckl.	3348	17	—	40		
M. reverchoni Vasey and Scribn.	3475	18	—	40		
M. repens (Presl.) Hitchc.	3312	19	—	60		
PANICEAE						
Paspalum pubiflorum Rupr.	3518	20	30	—		
P. langei Nash.	3519	21	—	40	60	(Burton 1942)
P. distichum L.	3396	22	—	40	40	(Brown 1948)
					48	(Burton 1942)
					60	(Saura 1941)
P. dissectum (L.) L.	3263	23	—	40	25	(Krishnaswamy 1940)
Panicum hians Ell.	3268	24	—	20	18	(Brown 1948)
P. obtusum H.B.K.	3364	25	—	20		
ditto	3288	26	—	40	36	(Brown 1948)
P. geminatum Forsk.	3411	27	—	40		
P. antidotale Retz.	SA-115	28	—	18	18	(Burton 1942)
P. anceps Michx.	3436	29	—	18	18	(Brown 1948)
P. filipes Scribn.	3293	30	—	18		
P. plenum Hitchc. and Chase	T-762	31	—	54		
P. bulbosum H.B.K.	3325	32	—	54		
ditto	3315	33	—	72	70	(Krishnaswamy 1940)
Eriochloa sericea (Scheele) Munro	3508	34	—	54		
Trichachne californica (Benth) Chase	3512	35	—	36	18	(Krishnaswamy 1940)
T. insularis (L.) Nees.	SA-4051	36	—	36		
T. patens Swallen	3520	37	—	72		
Leptoloma cognatum (Schult) Chase	3371	38	—	36	36	(Brown 1948)
ditto	3466	39	—	72		
Stenotaphrum secundatum (Walt) Kuntze	3275	40	9	—	18	(Brown 1950)
Brachiaria ciliatissima (Buckl.) Chase	3235	41	—	36		
ANDROPOGONEAE						
Erianthus strictus Baldw.	3442	42	—	30		
Manisuris cylindrica (Michx.) Kuntze	3517	43	—	18	18	(Reeves and Mangelsdorf 1935)
Elyonurus tripsacoides H. and B.	3461	44	—	20		
E. barbiculmis Hack.	3318	45	—	20		
Heteropogon contortus (L.) Beauv.	SA-4310	46	—	60	20	(Darlington and Janaki Ammal 1945)
Trachypogon montufari (H.B.K.) Nees	SA-4003	47	—	20		

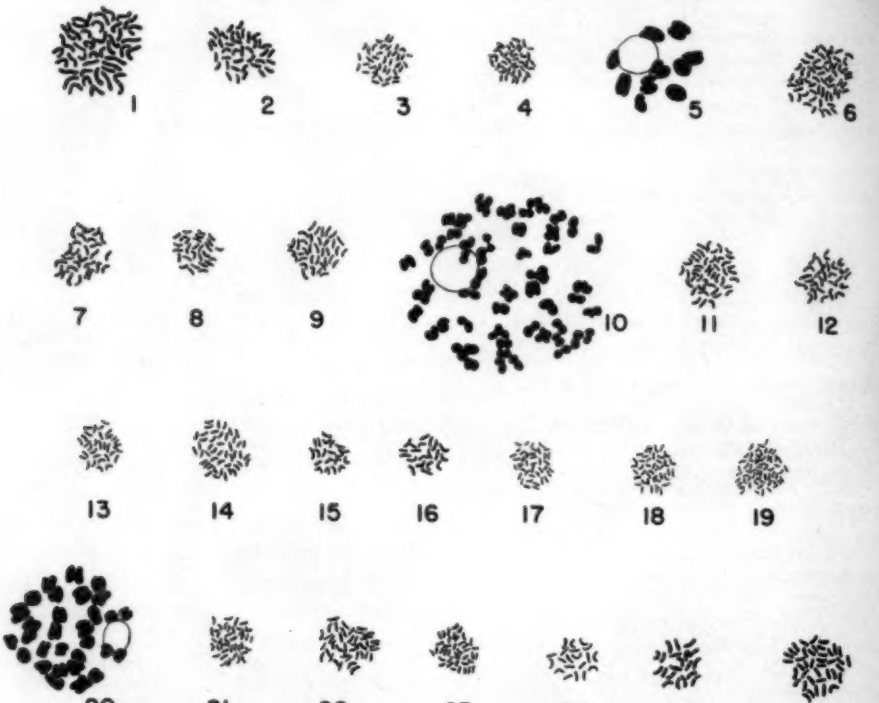


FIG. 1–47. Camera lucida drawings of chromosomes of the following Gramineae. Magnification ×1,000. FIG. 1. *Festuca arizonica*, $2n = 42$. FIG. 2. *Distichlis texana*, $2n = 40$. FIG. 3. *Eragrostis curtipedicellata*, $2n = 40$. FIG. 4. *Leptochloa virgata*, $2n = 40$. FIG. 5. *Chloris virgata*, $n = 10$. FIG. 6. *Trichloris pleuriflora*, $2n = 60$. FIG. 7. *Bouteloua hirsuta*, $2n = 28$. FIG. 8. *Lycurus phleoides*, $2n = 28$. FIG. 9. *Sporobolus poiretii*, $2n = 36$. FIG. 10. *S. airoides*, $n = 54$. FIG. 11. *Piptochaetium fimbriatum*, $2n = 44$. FIG. 12. *Stipa*

chromosomes (fig. 1) and a basic number of 7, typical of *Festuca* and related genera. *Distichlis texana* also in the Festuceae has, however, a basic number $x = 10$ and the chromosomes are small (fig. 2). Cytologically this species agrees with two other species of that dioecious genus in chromosome number and size, all three having $2n = 40$ small chromosomes. *D. spicata* (L.) Greene and *D. stricta* (Torr.) Rydb. are widespread in North America but *D. texana* is restricted to northern Mexico and two known locations in western Texas It is a much larger and more robust plant with stolons many feet in length that produce roots and erect plants at the nodes. The plant studied is staminate and was collected in a roadside ditch in Limpia Canyon of the Davis Mountains of west Texas.[1] Another genus with $x = 10$ small chromosomes is *Eragrostis* with *E. curtipedicellata*, a tetraploid species, having $2n = 40$ (fig. 3).

Chlorideae. A plant identified by the author as *Leptochloa virgata* collected near the coast of Texas has $2n = 40$ (fig. 4) and agrees with the count of that species made by Nunez (Parodi 1946) for Argentine material. This plant, however, has larger florets and longer awns than indicated in the description for *L. virgata*. The count of $n = 10$ in *Chloris virgata* (fig. 5) confirms the count of $2n = 20$ by Brown (1950) in contrast to $2n = 14$ and $2n = 30$ reported by previous authors. A plant of *Trichloris pleuriflora* that was acquired from the San Antonio station of the Soil Conservation Service is hexaploid with $2n = 60$ (fig. 6). Fults (1942) reported $2n = 21$, 37 and 42 in *Bouteloua hirsuta*. The present material has clearly $2n = 28$ (fig. 7).

Agrostideae. Species of certain genera in this tribe are abundant in Texas and some are of considerable forage value. *Lycurus phleoides*, abundant in the Davis Mountains, is such a species. In its basic number $x = 7$ (fig. 8) it agrees with related genera, although its presence in a hot

---

leucotricha, $2n = 26$. FIG. 13. *S. tenuissima*, $2n = 32$. FIG. 14. *S. eminens*, $2n = 46$. FIG. 15. *Muhlenbergia porteri*, $2n = 20$. FIG. 16. *M. polycaulis*, $2n = 20$. FIG. 17. *M. monticola*, $2n = 40$. FIG. 18. *M. reverchoni*, $2n = 40$. FIG. 19. *M. repens*, $2n = 60$. FIG. 20. *Paspalum pubiflorum*, $n = 30$. FIG. 21. *P. langei*, $2n = 40$. FIG. 22. *P. distichum*, $2n = 40$. FIG. 23. *P. dissectum*, $2n = 40$. FIG. 24. *Panicum hians*, $2n = 20$. FIG. 25. *P. obtusum* $2n = 20$. FIG. 26. *Ditto*, $2n = 40$. FIG. 27. *P. geminatum*, $2n = 40$. FIG. 28. *P. antidotale*, $2n = 18$. FIG. 29. *P. anceps*, $2n = 18$. FIG. 30. *P. filipes*, $2n = 18$. FIG. 31. *P. plenum*, $2n = 54$. FIG. 32. *P. bulbosum*, $2n = 54$. FIG. 33. *Ditto*, $2n = 72$. FIG. 34. *Eriochloa sericea*, $2n = 54$. FIG. 35. *Trichachne californica*, $2n = 36$. FIG. 36. *T. insularis*, $2n = 36$. FIG. 37. *T. patens*, $2n = 72$. FIG. 38. *Leptoloma cognatum*, $2n = 36$. FIG. 39. *Ditto*, $2n = 72$. FIG. 40. *Stenotaphrum secundatum*, $n = 9$. FIG. 41. *Brachiaria ciliatissima*, $2n = 36$. FIG. 42. *Erianthus strictus*, $2n = 30$. FIG. 43. *Manisuris cylindrica*, $2n = 18$. FIG. 44. *Elyonurus tripsacoides*, $2n = 20$. FIG. 45. *E. barbiculmis*, $2n = 20$. FIG. 46. *Heteropogon contortus*, $2n = 60$. FIG. 47. *Trachypogon montufari*, $2n = 20$.

[1] The author is much indebted to Dr. Barton Warnock of Sul Ross State Teachers College in Alpine, Texas, whose knowledge of the plants of Trans-Pecos Texas made the collection of this species and many others possible.

dry habitat is in sharp contrast to other genera of the tribe with $x = 7$ which are grasses chiefly of cool moist regions. Most species of Agrostideae native to Texas are in genera with basic numbers other than $x = 7$. A few examples follow. A count of $2n = 36$ for *Sporobolius poiretii* (fig. 9) confirms that of Avdulow (1931). The plant of *Sporobolus airoides* studied has $n = 54$ chromosomes (fig. 10). This plant is 12-ploid with $x = 9$ and is evidently a different cytological strain from the California material studied by Stebbins and Love (1941) which was 14-ploid with $2n = 126$. The first determination of the chromosome number in the genus *Piptochaetium* was $2n = 22$ in 6 species and three varieties by Covas and Bocklet as well as Valencia (see Parodi 1946). *P. fimbriatum*, the only species native to United States, also has $2n = 22$ (fig. 11). The basic number $x = 11$ is also found in *Stipa Brachyelytrum* and *Aristida*, genera that show morphological evidences of interrelationship. From the cytological study of the genus *Stipa* by Stebbins and Love (1941) it is known that aneuploidy is prevalent in the North American species of *Stipa* although most South American species investigated have $x = 11$. Additional aneuploidy found in the genus by the present study is $2n = 26$ in *Stipa leucotricha*, (fig. 12), 32 in *S. tenuissima* (fig. 13) and 46 in *S. eminens* (fig. 14). This last determination confirms the count of Love (see Myers 1947) for *S. eminens*. All species of *Muhlenbergia* so far studied (18 species) have a basic number $x = 10$ except for *M. filiformis* which is reported to have $2n = 18$ (Myers 1947).The present investigation includes five of these eighteen species (fig. 15 to 19).

Paniceae. Of the four species of *Paspalum* studied, three have chromosome numbers different from those previously reported. Two of these, *P. langei* and *P. distichum*, are examples of intraspecific variation in polyploidy that is so common in many genera of the Gramineae. *Paspalum pubiflorum* $n = 30$ (fig. 20) is reported for the first time. This species is a weedy type in central Texas and, unlike most species of the genus, is able to survive dry hot summers. As indicated in Table 1 three chromosome numbers have been reported for *P. distichum*, 40, 48 and 60. The present study agrees with that of Brown (1948) rather than Burton (1942). Saura (1941) found his South American material of this species to be hexaploid with the basic number $x = 10$ characteristic of this genus. Krishnaswamy (1940) reported $2n = 25$ for *P. dissectum* but Texas material clearly shows $2n = 40$ (fig. 23). The very large genus *Panicum* is characterized by the basic number x = 9, although $x = 7$ has been found in one species (Brown 1950) and $x = 10$ in some South American species (Nunez. in Parodi 1946). The present study reports $x = 10$ in three United States species. Brown (1948) reported P. *hians* and *P. obtusum* to have $2n = 18$ but in the present study Texas material of these two species show $2n = 20$ (fig. 24 and 25) as well as one tetraploid plant of *P. obtusum* with $2n = 40$ (fig. 26). *P. geminatum* also has $2n = 20$ (fig. 27) which

may indicate a relationship with *Paspalum*. The five other species of the genus studied have $x = 9$ (fig. 28 to 32). Krishnaswamy (1940) found $2n = 70$ in *P. bulbosum* but the present material has $2n = 54$ (fig. 32) and $2n = 72$ (fig. 33). Of the three species studied of *Trichachne, T. californica* and *T. insularis* have $2n = 36$ (fig. 35 and 36) while *T. patens* has $2n = 72$ (fig. 37). The present study reports a teraploid plant of *T. californica* whereas Krishnaswamy (1940) reported a diploid, $2n = 18$, in that species called by him *Panicum californicum* Benth. *Leptoloma cognatum* reported by Brown (1948) to have $2n = 36$ was found to have also $2n = 72$ in Texas material (fig. 38 and 39). Brown (1950) reported *Stenotaphrum secundatum* to have $2n = 18$. This has been corroborated by a study of meiotic chromosomes which shows $n = 9$ (fig. 40) for the same plant previously investigated.

Andropogoneae. In *Erianthus* most species studied have $x = 10$ with counts of $2n = 20$, 40 and 60. *E. strictus,* however, has $2n = 30$ (fig. 42). This indicated either a basic number of $x = 5$ or a derived basic number of $x = 15$. This is the first American species of the genus to be studied cytologically. Reeves and Mangelsdorf (1935) reported *Manisuris cylindrica* to have $n = 9$ and $2n = 18$ chromosomes. This number was confirmed in the present study (fig. 43). Avdulow (1931) reported *Rotboellia glandulosa* Trin. (a closely related genus) to have $2n = 54$, also with a basic number $x = 9$. It was unexpected, therefore to find in two species of *Elyonurus,* another genus close to *Manisuris,* that $x = 10$, both species having $2n = 20$ (fig. 44 and 45). A striking feature of the chromosomes of *Elyonurus* is their large size. In general the chromosomes of the Andropogoneae are small compared to the large chromosomes typical of Festuceae and Hordeae. However, in the case of *Elyonurus* the chromosomes of the two species studied were longer and thicker than those of *Festuca arizonica* and *Bromus catharticus,* representing Festuceae, but shorter than those of *Elymus interruptus* and *Sitanion hystrix,* representing the Hordeae, in approximately the length ratio of Festuceae 8 : *Elyonurus* 10 : Hordeae 13. The chromosomes of *Elyonurus* are nearly twice the length of those of *Manisuris* and much thicker. In spite of this cytological difference between *Manisuris* and *Elyonurus* the morphological similarities are sufficient to justify their present taxonomic relationship. Darlington and Janaki Ammal (1945) report *Heteropogon contortus* to have $2n = 20$. The Texas material studied is hexaploid with $2n = 60$ (fig. 46). In the related genus *Trachypogon* the species *T. montufari* is diploid with $2n = 20$ (fig. 47). The chromosomes of these last two genera are of the size characteristic of the Andropogoneae.

It is apparent from this and other cytological studies of grasses that basic chromosome number and chromosome size are not constant throughout many of the large tribes. Genera with a basic number $x = 7$ almost always have large chromosomes but genera with $x = 8$, 9, 10, 11, 12, etc. have small

chromosomes. *Elyonurus* is an exception to this since it has a basic number $x = 10$ but the chromosomes are large. It seems evident from morphological, cytological and anatomical data that most of the commonly recognized tribes are unnatural and should be divided into subtribes or into a larger number of tribes. This has been proposed in some systematic treatments of grasses such as Hubbard's (1934) treatment. Anatomical and cytological studies are in general agreement in pointing out these natural groups that are, nevertheless, delimited basically by morphological characteristics. Further examples of different basic chromosome numbers in the commonly accepted tribes are: *Festuca* $x = 7$ large chromosomes in contrast to *Distichlis* and *Eragrostis* $x = 10$ small chromosomes; *Chloris* and others $x = 10$ (or 5), *Bouteloua* $x = 7$; *Lycurus* $x = 7$, *Sporobolus* $x = 9$, *Muhlenbergia* $x = 10$ and Aneuploidy in *Stipa;* in *Panicum* $x = 7, 9$ and 10; and in the Andropogoneae $x = 9$ in *Manisuris* but $x = 10$ in other genera.

SUMMARY

1. The chromosome numbers of 44 species in 24 genera of Gramineae are reported. Of these the chromosome numbers of 25 species are reported for the first time.

2. The very restricted species *Distichlis texana* agrees with the widespread species *D. spicata* and *D. stricta* in having $2n = 40$ small chromosomes.

3. *Piptochaetium fimbriatum,* the only species of the genus in the United States, agrees with South American species in having $2n = 44$ and this chromosome number shows the relationship of this genus to *Stipa, Aristida* and *Brachyelytrum.*

4. *Stipa tenuissima* is aneuploid in a genus that is typically aneuploid.

5. The basic number in *Panicum hians, P. obtusum* and *P. geminatum* is $x = 10$. *Erianthus strictus,* the first American species in this genus to be studied cytologically has $2n = 30$ indicating a basic number of 5 or 15.

6. The basic number in *Elyonurus* and *Trachypogon* is $x = 10$, with *Elyonurus* having, perhaps, the largest chromosomes in the Andropogoneae.

The Plant Research Institute,
The University of Texas and
The Clayton Foundation for Research

Literature Cited

Avdulow, N. P. 1931. Karyo-systematische Untersuchungen der Familie Gramineen. Bull. Appl. Bot. Pl. Breed. Suppl. **44.**

Brown, W. V. 1948. A cytological study in the Gramineae. Am. Jour. Bot. **35**: 382–395.

———. 1949. A cytological study of cleistogamous *Stipa leucotricha.* Madroño **10**: 97–107.

———. 1950. A cytological study of some Texas Gramineae. Bull. Torrey Club. 77: 63–76.

Burton, G. W. 1942. A cytological study of some species in the tribe Paniceae. Am. Jour. Bot. **29**: 355–359.

Darlington, C. D. and Janaki Ammal, E. K. 1945. Chromosome atlas of cultivated plants. London.

Fults, J. L. 1942. Somatic chromosome complements in *Bouteloua*. Am. Jour. Bot. **29**: 45–55.

Hitchcock, A. S. 1935. Manual of the grasses of the United States. U. S. Dept. Agric. Misc. Publ. 200.

Hubbard, C. E. 1934. Gramineae. In Hutchinson, J., The families of flowering plants. II. Monocotyledons: 199–209. London.

Krishnaswamy, N. 1940. Untersuchungen zur Cytologie und Systematik der Gramineen. Bot. Centralbl. **60**: 1–56.

Myers, W. M. 1947. Cytology and genetics of forage grasses. Bot. Rev. **13**: 319–421.

Parodi, L. R. 1946. Gramineas Bonarienses. Buenos Aires.

Reeves, R. G. and Mangelsdorf, P. C. 1935. Chromosome numbers in relatives of *Zea mays* L. Am. Nat. **69**: 633–635.

Sura, F. 1941. Cariologia de algunas especies del genero *Paspalum*. Univ. Buenos Aires Publ. Fac. Agric. y. Vet. Inst. Genet. **2**: 41–48.

Stebbins, G. L. and Love, R. M. 1941. A cytological study of California forage grasses. Am. Jour. Bot. **28**: 371–382.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, No. 4, pp. 300–309 JULY, 1951

SUPPLEMENTARY NOTES ON SOUTH AMERICAN HYDROCOTYLE

MILDRED E. MATHIAS AND LINCOLN CONSTANCE

The genus *Hydrocotyle* (*Umbelliferae*) has long been one of interest in Andean South America. It is represented there by many species, their outstanding morphological differences readily manifest in characters of foliage and pubescence. In 1936 the senior author published a revision of the genus in northern South America (Brittonia **2**: 201–237). In the fourteen years since that publication probably even more material has been studied than was available at the time of the revision. Much of this material has been of recent collecting—Camp, Cuatrecasas, Ewan, Steyermark. It is gratifying to note that the study of these extensive collections, while adding substantially to our knowledge of species distributions and morphological variations, has not materially changed the taxonomic treatment given in the 1936 revision.

The following notes are deemed worthy of publication since they supplement the earlier revision. The numbers preceding the species are those used in that revision, and page citations are to the same publication. The four species added herein are numbered to indicate their presumed relationship to the species previously known and described.

7. H. ACUMINATA Urban. PERU: Huancavelica: Prov. Tayacaja, Montepungo, 5 km. east of Surcubamba, 3000 m., vine climbing to 1.5 m., *Stork & Horton 10390* (UC). Cuzco: Prov. Paucartambo, Sta. Isabel, 1320 m., *Vargas 6763* (UC). This species has been recorded from Peru with collections by *Sander & Sons* and *Lechler 2305* but in neither case is exact locality given.

7a. H. ACUMINATA var. **pubescens** Math. & Const., var. nov.

Planta *H. acuminatam* simulans; caulibus et pedunculis pilosis, foliorum laminis et petiolis plus minusve hirsutis.

Stems pilose with white patent hairs to glabrate; leaves hirsute below, sparsely hirsute on the nerves and veins above; petioles hirsute; peduncles pilose, especially below.

TYPE SPECIMEN: *Herzog 2156*, in Hohlwegen des Bergwaldes über Tablas, Bolivia, 2700 m., May 1911 (Leiden, Rijksherbarium 602280; photos of Leiden specimen: LA, UC).

DISTRIBUTION: Known only from the type collection.

Herzog collected two entities under his number 2156. The specimen seen at the Botanisches Museum, Berlin-Dahlem, was cited as *H. boliviana* in the senior author's revision of the genus cited above. Dr. van Ooststroom has called out attention to the second entity, *Herzog 2156* in the Rijksherbarium, Leiden, which becomes the type of this new variety.

9. H. HITCHCOCKII Rose. ECUADOR: Napo-Pastaza: densely forested slopes along río Pastaza between río Topo, at Topo, and Mera, 5200 feet, creeping along ground in woods, *Steyermark 54888* (F). Tunghurahua: río Margarjitas below Baños, 1225 m., *Penland & Summers 160* (UC). These are the second and third collections of this species which was previously known only from the type collection, *Hitchcock 21892*.

10. H. QUINQUELOBA R. & P. ECUADOR: Santiago-Zamora: between Loma de Galápagos and headwaters of río Tintas, 3200–3505 m., vining and hanging from branches, *Steyermark 53500* (F, LA, UC). This collection is the first for the species from Ecuador although the closely related *H. yanghuangensis* is known from Azuay (Cuenca). The leaves are 4-lobed as in the latter, but *H. quinqueloba* from Brazil may have 3–8-lobed leaves. In all other respects these specimens are a closer match for *H. quinqueloba* than *H. yanghuangensis*.

11. H. YANGHUANGENSIS (Hieron.) Mathias. ECUADOR: Azuay: Eastern Cordillera, 4–6 km. north of the village of Sevilla de Oro, 9,000–10,000 feet, plants on soil or scrambing up mossy trees and rooting at nodes, stems and petioles usually purplish, leaves deep green, subnitid above, paler below, perianth dull purplish overcast on light green, *Camp E-4731* (NY, UC). The species has been known only from the type collection, *Lehmann 5590*, from the same region.

12. H. PERUVIANA Wolff. PERU: Cuzco: Pillahuata, Prov. Pauecartambo, 2800 m., *Vargas 1905* (LA).

14. H. LEHMANNI Mathias. COLOMBIA: El Valle: Cordillera Central, vertiente occidental, Hoya del río Bugalagrande, Barragán, Páramo de Bavaya, Corrales, 3550–3400 m., *Cuatrecasas 20586* (LA, UC). Cauca: Cordillera Central, vertiente occidental, Cabeceras del río Palo, Quebrada del río Lopez, Alto del Duende, matorrales y bosquecillo de páramo, 3300–3350 m., *Cuatrecasas 18873* (LA, UC). Putumayo: lado sur de la Laguna de la Cocha, Quebrada de Santa Lucía, bosque, 2850 m., leaves up to 9 cm. in diameter, *Cuatrecasas 11827-A* (F, US); Laguna de la Cocha (north shore), vicinity Hacienda of Carlos Bracht, 2850 m., flowers yellowish green, rather stout vine climbing about thicket and trailing over herbaceous species on ground, locally abundant, foliage with strong scent of bitter parsley, *Ewan 16375* (UC, USNA); Páramo de Tabano south of Pasto, 12,000 feet, *Balls 7505* (UC). This species was described from specimens collected in Cauca. It is of interest to record this more detailed record for Cauca and the additional collections from El Valle and Putumayo. The more robust specimens show leaves up to 11 cm. in diameter and the umbels are generally fewer flowered, with an average of about 30 flowers in the umbel.

17. H. HUMBOLDTII A. Rich. var. HUMBOLDTII. ECUADOR: Chimborazo: peak east of hacienda buildings, Joyagshi, 10,500 feet, plant creeping, flowers yellow but pale, *Wiggins 10730* (UC). Azuay: Pacific side of pass, Nudo de Portete, pass between headwaters of the ríos Tarqui (Atlantic) and Giron (Pacific), ca. 9,000 feet, trailing over banks, stems and petioles red, leaves deep green above, usually dull, pale green and nitid below, corolla segments dull white, ovary and disc green, *Camp E-2157* (NY, UC).

17a. H. HUMBOLDTII VAR. MACROPHYLLA Mathias. COLOMBIA: Antioquia: en bosque abierto y húmedo en los alrededores de Sonson, ca. 2545 m., *Scolnik & Barkley 19An180* (UC). Cundinamarca: between Soacha and El

Colegio, 35 km. west of Bogotá, 7000 feet, creeping on vertical wet mossy rock-cut, *Fassett 25846* (UC, USNA). Tolima: along Quindío highway between Cajamarca and summit of divide, 3000–3100 m., herbaceous vine, inflorescence green, deep forest, *Killip & Varela 34646* (UC). ECUADOR: El Oro: between Paccha and Puente Grande, passing over Montaña de Pueblo Viejo, Cordillera Suchiquilla, Montaña Huahuel, Cordillera de Dumán and Sambotambo, 1830–2430 m., "orijuela," cattle supposedly poisoned by eating leaves, *Steyermark 54133* (F, UC). Pichincha: Canto Quito, Alasponga, trail Nono to Gualea in dense forest, 3125 m., vine twining through underbrush, greenish-white flower, *Mexia 7702* (UC). Santiago-Zamora: along río Valladolid, around Tambo Valladolid, 2000 m., creeping and climbing as epiphyte, leaves pale green below, *Steyermark 54675* (F, LA). The last-cited collection has up to 50 flowers in the umbel and long, slender pedicels attaining 15 mm.

17b. H. HUMBOLDTII VAR. PUBESCENS Mathias. COLOMBIA: Cundinamarca: forest, Salto de Tequedama, Cordillera Oriental, 2300–2400 m., *Cuatrecasas 158* (US); Tequendama Falls at edge of sabana of Bogotá, *Schiefer 977* (UC). El Valle: Cordillera Central, vertiente occidental, Cabeceras del río Tuluá, Quebrada de Las Vegas, páramo, 3400–3500 m., *Cuatrecasas 20371* (F); Cordillera Central, vertiente occidental, Hoya del río Bugalagrande. Barragán, Páramo de Bavaya, 3680–3600 m., *Cuatreceasas 20077* (LA, UC). BOLIVIA: Nor Yungas: Depto. La Paz, near Unduavi, 3200 m., vine in dense thicket trailing among rocks and on bushes, *Eyerdam 25129* (UC).

The treatment of the species falling in Dr. Mathias' key (p. 203) under the phrase, "Leaves parted to the base or nearly to the base," requires rather extensive emendation. The following key summarizes our present interpretation of the distinctive characters of the members of this group.

Leaves not peltate, or if peltate the blade palmately divided.
- Leaves parted to the base or nearly to the base.
  - Leaves apparently trifoliate, less than 1 cm. broad. ..... 18. *H. minutifolia*
  - Leaves apparently 4–5 parted (actually trifoliate, with the lateral lobes parted nearly to the base), more than 1 cm. broad.
    - Leaflets incised-dentate or lobed.
      - Stems glabrous; leaves hirsute or hirsutulous on the nerves with appressed, ascending hairs.
        - Leaflets merely incised, puberulent; umbels 15–20-flowered; fruit orbicular ..... 19. *H. sphenoloba.*
        - Leaflets deeply lobed, hirsute; umbels ca. 10-flowered; fruit transversely elliptical ..... 19a. *H. nixoides.*
      - Stems pubescent; leaves hirsute with divaricate hairs, or villous.
        - Peduncles 4–5 cm. long, sparingly hirsute; umbels 30–35-flowered; pedicels 3–6 mm. long; Peru ..... 21. *H. palmata.*
        - Peduncles 6–10 cm. long, glabrous; umbels 15–20-flowered; pedicels 1.5–2 mm. long; Ecuador. 21a. *H. lachnolina.*
    - Leaflets bipinnatifid ..... 20. *H. multifida.*

19. H. SPHENOLOBA Wedd. and 20. H. MULTIFIDA A. Rich. The previous interpretation of these two species (pp. 218–219), based in part upon comparisons made by Mr. E. P. Killip at Paris, was completely reversed. Thus,

the description given under *H. sphenoloba* actually applies to *H. multifida*, and that given under *H. multifida* applies to *H. sphenoloba*. The original difficulty was caused by the fact that Goudot collected both species: the type of *H. sphenoloba* at Azufral, Ibagué, in Cauca, and excellent material of *H. multifida* at Quindío, in Caldas. We are especially indebted to Professor H. Humbert for giving us an opportunity to re-study these critical collections. The photographs taken by Mr. J. F. Macbride of *H. multifida* [F 37,071] and of *H. sphenoloba* [F 37,072] first indicated that the original interpretation had been in error. The following collections may now be cited as characteristic of the two species.

19. H. SPHENOLOBA Wedd. (Fig. 1B). COLOMBIA: Caldas: Cerro Tatama, Cordillera Oriental, *Pennell 10485* (NY, US). Cauca: "Nelle Grenade: à l'Azufral d'Ibagué," *Goudot* (P, part of type; photo of Paris type: UC, US).

20. H. MULTIFIDA A. Rich. (Fig. 1C). COLOMBIA: Caldas: Quindío, Páramo de los Corales, 1844, *Goudot* (P); Quindío, *Dawe 811* (NY); Las Cruces, río Tochesito (Quindío), *André 2289* (NY); "Pinares" above Salento, Cordillera Central, *Pennell 9349* (NY, US). Cundinamarca: "Ad cataractam Tequendamam," *Holton 638* (NY); San Miguel to Aguadita, Eastern Cordillera, *Killip 38093* (US); west slope of Peña Blanca 8 km. southeast by east of El Colegio, 35 km. south by west of Bogotá, *Fosberg & Hermann 21390* (UC, USNA); San Isídro, 8 km. south of Gachalá, Cordillera Oriental, *Grant & Fosberg 9318* (UC, USNA). Cauca: Almaguer, *Humboldt & Bonpland* (photo of Paris type: UC, US). The suggestion that *H. multifida* perhaps does not occur in the Eastern Cordillera must be withdrawn in view of the additional collections from that range.

19a. **Hydrocotyle nixoides**, sp. nov. (Fig. 1A).

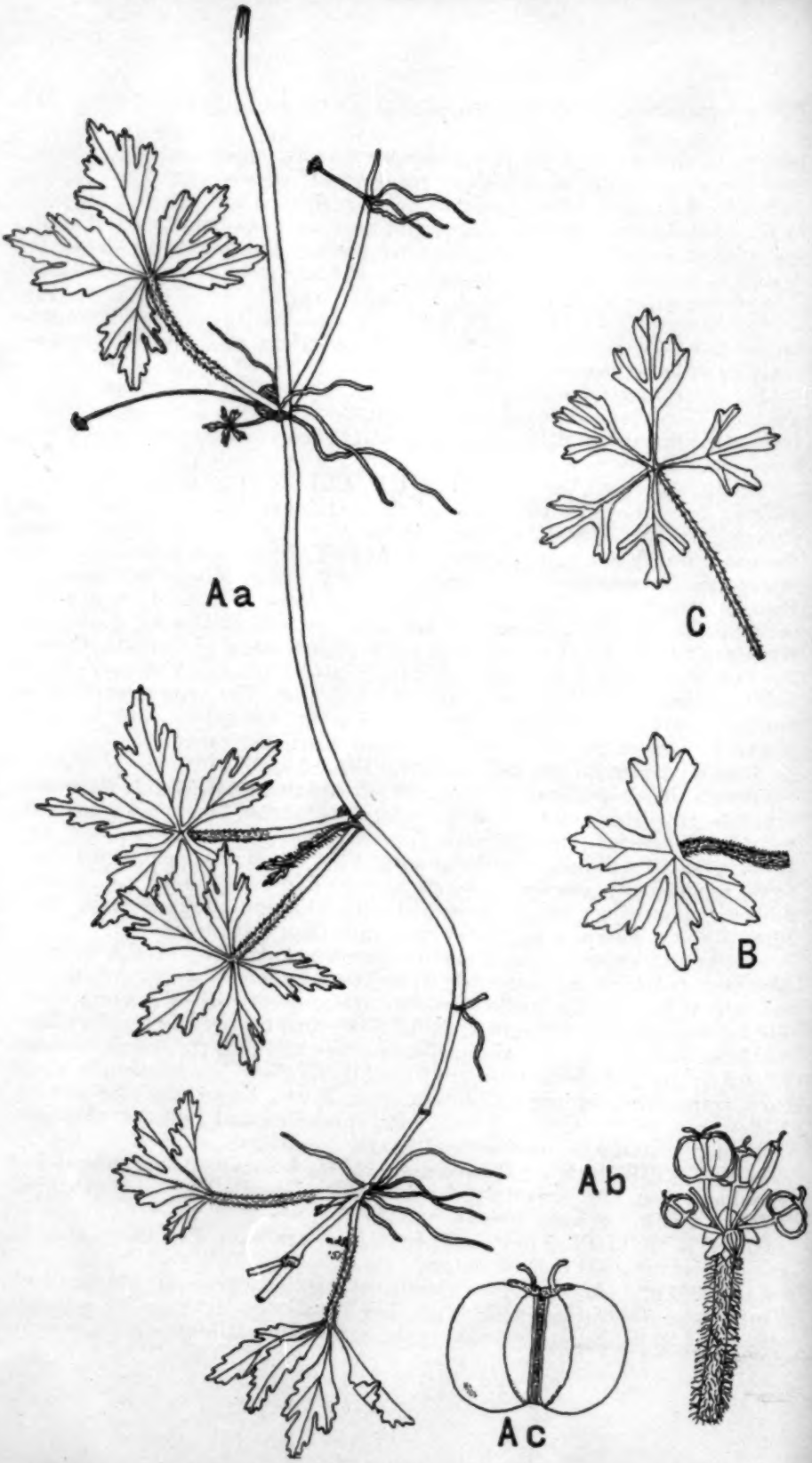
Planta *H. multifidam* A. Rich. et *H. sphenolobam* Wedd. simulans; caulibus gracilibus, glabris; foliis palaceis (?), 2.5–4 cm. diametro, trifoliatis, apparenter quinquefoliatis, foliolis ovato-cuneatis, valde lobatis, hirsutis, petiolis gracilibus, retrorso-hirsutis, 1.5–6 cm. longis; pedunculis quam foliis longioribus, gracilibus, supra retrorso-hirsutis, 2.5–6.5 cm. longis; umbellis simplicibus, ca. 10-floris, pedicellis 1–2 mm. longis, glabris; fructibus, 1.5 mm. longis, 2 mm. latis, costis gracilibus, distinctis.

Stems slender, creeping, glabrous; leaves not peltate (?), 2.5–4 cm. in diameter, trifoliate, appearing 5-foliate because of the extreme lobation of the lateral leaflets, the leaflets cuneate-ovate, deeply lobed, hirsute above and below at least on the nerves, the lobules acute, the petioles slender, 1.5–6 cm. long, retrorse-hirsute; peduncles usually exceeding the leaves, slender, 2.5–6.5 cm. long, glabrous below, retrorse-hirsute above; umbels simple, about fruit transversely elliptical, 1.5 mm. long, 2 mm. broad, the ribs slender, 10-flowered, the pedicels 1–2 mm. long, spreading and reflexed, glabrous; distinct, the stylopodium depressed.

TYPE SPECIMEN: *Cuatrecasas 21694*, bosques, Almorzadero, Los Farallones, vertiente orientale, Cordillera Occidental, El Valle, Colombia, 2900 m., 25 July, 2 Aug., 1946. (UC 753616.)

DISTRIBUTION: Known only from Los Farallones, El Valle, Colombia, at elevations of 2900 to 3300 meters.

COLOMBIA: El Valle: Los Farallones, vertiente oriental, Almorzadero, *Cuatracasas 21694* (LA, UC: type; Los Farallones, extreme N, vertiente oriental, Alto del Buey, hierba reptante, verde clara, tallos restreros, rosados


Aa
C
B
Ab
Ac

o verdoso amarillento pallidos, *Cuatrecasas 18082* (LA, UC); Los Farallones, vertiente NW, Quebrada de Las Nieves, abajo de la mina El Diamante, *Cuatrecasas 21782* (LA, UC).

This species falls between *H. sphenoloba* and *H. multifida* in degree of leaf dissection, but it is readily distinguishable from both by being more hirsute and by possessing a transversely elliptical rather than an orbicular fruit. It is conceivable that further collecting will reveal all three of these to be merely forms of a single species. Sufficient material is not yet available, however, to support such a conclusion, and the specimens described here cannot be assigned to either of the earlier-named taxa.

21. H. PALMATA Mathias. PERU: Cuzco: Prov. Urubamba, Puyupata, 3600 m., *Vargas 2874* (LA, UC). This species has been known only from the type collection, *Mathews 1637*, from Amazonas.

21a. H. LACHNOLINA Diels, Notizbl. **14**: 339. 1939.

Stems rooting at the nodes, densely and conspicuously villous with pale, retrorse hairs; leaves 5–7 cm. in diameter, 5-foliate, the leaflets elongate-obovate, cuneate, sometimes trilobed toward the apex, serrate, the serrations palely cartilaginous, pallid-villous on both surfaces, densely so beneath, the petioles 5–10 cm. long, pallid-villous; peduncles slender, glabrous, 6–10 cm. long; umbels simple, 15–20-flowered, the pedicels 1.5–2 mm. long; ovary glabrous, the fruit not seen.

TYPE SPECIMEN: *Sydow 502*, Baños, bei der Hacienda San Antonio, Ost-Kordillere, Mittle-Ecuador, 10 Dec., 1937.

DISTRIBUTION: Known only from the type collection.

This species was published subsequent to the appearance of the earlier revision of the genus, and we have seen no representative of it. From the original description, however, it appears to represent a valid entity which must be taken into account.

26. H. ACUTIFOLIA R. & P. ECUADOR: Santiago-Zamora ("Oriente"): along narrow flood-plain of río Itzintza, Cordillera Cutucu, 3500–3700 feet, ca. 2°40′S., 78°W., corolla cream white, *Camp E-1239* (NY, UC). This species has been reported only from Peru.

28. H. GUNNERIFOLIA Wedd. COLOMBIA: Tolima: along Divide near Quindío highway, 3300–3500 m., herbaceous vine, *Killip & Varela 34591* (UC). Cauca: Cordillera Central, vertiente occidental, Cabeceras del río Páez, páramos entre Perro Muerto y la Laguna del Páez, 3550–3450 m., *Cuatrecasas 19028A* (LA); Cordillera Central, filo de la Cordillera, páramo del Puracé, en San Rafael, 3400 m., *Cuatrecasas 14808* (LA, UC). Putumayo: Alta Cuenca del río Putumayo en el Valle de Sibundoy, bosque paramero en el filo de la Cordillera, La Cabaña, 2800 m., *Cuatrecasis 11619* (LA, UC, US).

30. H. TAMBALOMAENSIS Wolff. ECUADOR: Azuay: Eastern Cordillera, 1–8 km. north of the village of Sevilla de Oro, 8000–9000 feet, trailing over banks, stems purplish, leaves very dark green above, pale green below, perianth pale green, *Camp E-4297* (NY, UC).

FIG. 1. A. *Hydrocotyle nixoides*. a. Habit, ×1. b. Umbellet, ×5. c. Mature fruit, ×15. B. *H. sphenoloba*, foliage leaf, ×1. C. *H. multifida*, foliage leaf, ×1.

30a. **H. Steyermarkii, sp. nov. (Fig. 2).**

Planta caulibus gracilibus, rufo-villosis; foliis palaceis, orbiculari-reniformibus, 7.5–11 cm. diametro, angulate 5–7-lobatis, lobis triangularibus, 3–5-lobulatis, spinuloso-serratis, nervis venisque dense villosis, petiolis glabris; pedunculis quam foliis brevioribus, glabris; umbellis simplicibus, ca. 30-floris, pedicellis gracilibus, ca. 4 mm. longis, glabris; fructibus immaturis glabris, ca. 1.2 mm. diametro, costis distinctis.

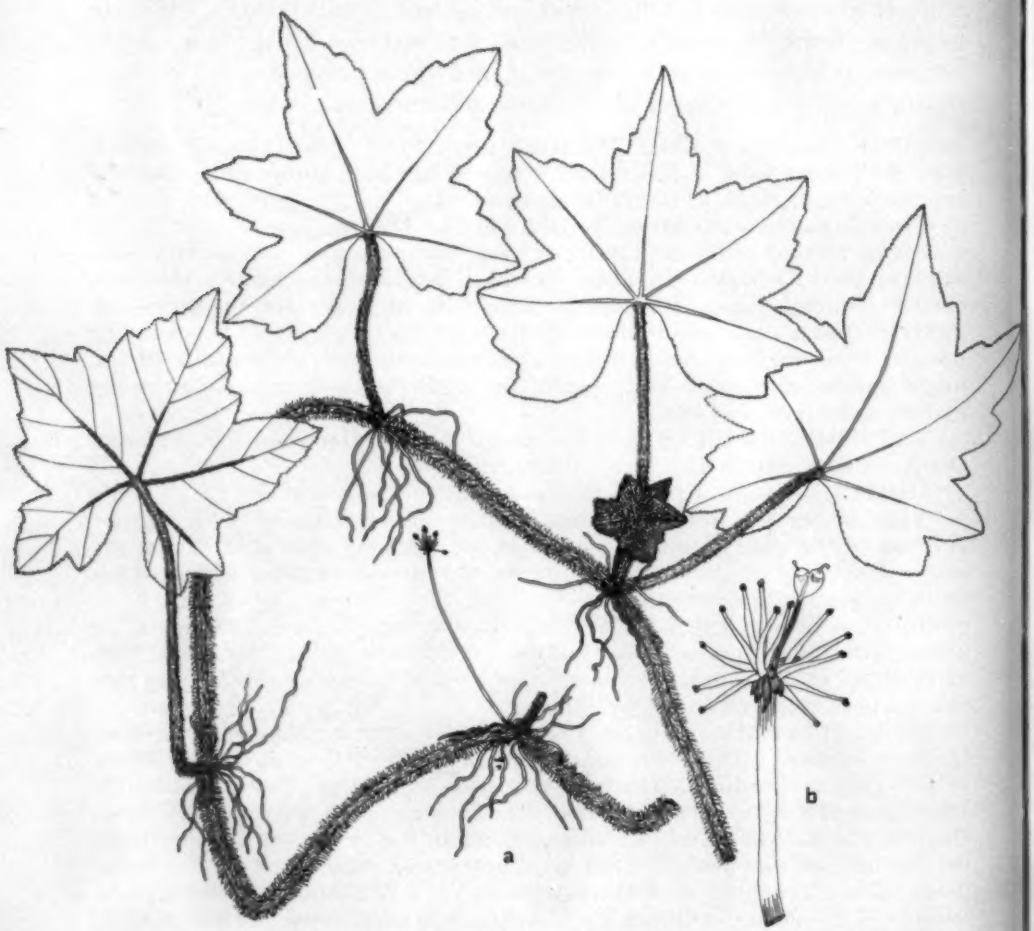


FIG. 2. *Hydrocotyle Steyermarkii*. a. Habit, × ca. ⅓. b. Umbellet, × 2.

Stems slender, creeping, rufo-villous; leaves suborbicular, slightly broader than long, not peltate, 7.5–11 cm. in diameter, villous above and below on the nerves and veins, densely villous when young, 5-nerved, angulately 5–7-lobed about half the distance to the sinus, the lobes deltoid, 3–5-lobulate, spinulose-serrate, acute to subacuminate, the petioles 7–10 cm. long, densely villous especially above with divaricate hairs; peduncles slender, glabrous, 5 cm. long, shorter than the leaves; umbels simple, about 30-

flowered, the pedicels slender, about 4 mm. long, reflexed and spreading, glabrous; immature fruit suborbicular, about 1.2 mm. in diameter, glabrous, the ribs evident, the stylopodium depressed.

TYPE SPECIMEN: *Steyermark 54566*, along Quebrada Honda, vicinity of Rancho Achupallas, Santiago-Zamora, Ecuador, altitude 2500–2700 m., 10 Oct., 1943. (F 1250137.)

DISTRIBUTION: Known only from the type collection.

ECUADOR: Santiago-Zamora: along Quebrada Honda, vicinity of Rancho Achupallas, stems creeping on ground, *Steyermark 54566* (F: type, LA; UC: photo of Chicago specimen).

This species is most closely related to *H. tambalomaensis* Wolff and *H. venezuelensis* Rose. It differs from both in its rufo-villous rather than hirsute stems, its much larger, spinulose-serrate rather than merely serrate or crenate leaves, and in having the peduncles shorter than the leaves.

31. H. HEDERACEA Mathias. COLOMBIA: Santander: vicinity of Las Vegas, Eastern Cordillera, 2600–3000 m., dense woods along stream, *Killip & Smith 16023* (US). Norte de Santander: Eastern Cordillera, road from Pamplona to Toledo, crossing the divide between río La Teja (Maracaibo drainage) and río Mesme (Orinoco drainage), 2800–3000 m., dense woods, *Killip & Smith 20004* (US). Cundinamarca: Los Goques, western slope of Páramo de Guasca, ca. 3250 m., woods along stream, *Killip 34159* (UC). Cauca: Cordillera Central, vertiente oriental, región de Moscopán, Hoya del río San Jose, Aguabonita, bosques, 2280 m., *Cautrecasas 23517* (LA). These are the first records for the species from the Eastern Cordillera of Santander, Norte de Santander, and Cundinamarca.

32. H. URBANIANA Wolff. PERU: Cuzco: Hda. Vilcabamba, Calca, 2700 m., *Vargas 3900* (LA). This species has been described with pedicels 2–3 mm. long, but this specimen has pedicels up to 5 mm. long in the flowering umbel.

34. H. VENEZUELENSIS Rose. VENEZUELA: Aragua: en la selva de Maracay-Choroní, 1500 m., yerba rastrera de las orillas de la carretera, *Tamayo 1655* (US). Lara: between Bueños Aires to Canyon of El Callado, above Humocaro Alto, 2285–2740 m., creeping on moist shaded ground along dry stream bed, *Steyermark 55520* (F, LA, UC).

35. H. GROSSULARIAEFOLIA Rusby. COLOMBIA: Magdalena: Cerro Chinchicuá, 2600 m., *Bro. Apolinar Angel 725* (US); Cero San Lorenzo, ca. 2500 m., *Bro. Apolinar Angel 608* (US). Cundinamarca: 12 km. west-southwest of Junin, on the río Blanco, a small affluent of río Piedra de Sal, drainage of río Sueva, lat. 4° 44′ N., long. 73° 46′ W., Cordillera Oriental, 2900 m., extensively creeping, openings in woods, common, *Fosberg 21490* (UC, USNA). This species has been recorded only from the Sierra Nevada de Santa Marta at elevations of from 1500 to 2150 meters.

37a. **H. Cuatrecasasii**, sp. nov. (Fig. 3).

Planta caulibus gracilibus, glabris; foliis palaceis, orbiculari-reniformibus, 0.5–1 cm. diametro, angulate 5–7-lobatis, lobis triangularibus, rotundis vel truncatis, 3–5-lobulatis, crispato-hirsutis, petiolis supra crispato-hirsutis; pedunculis quam foliis longioribus, glabris; umbellis simplicibus, 9–14-floris, pedicellis gracilibus, ca. 2 mm. longis; fructibus glabris, ca. 1 mm. longis, 1.5–2 mm. latis, costis distinctis, acutis.

Stems slender, creeping, glabrous; leaves orbicular-reniform, not peltate, 0.5–1 cm. in diameter, crispate-hirsute above, glabrous below, angulately

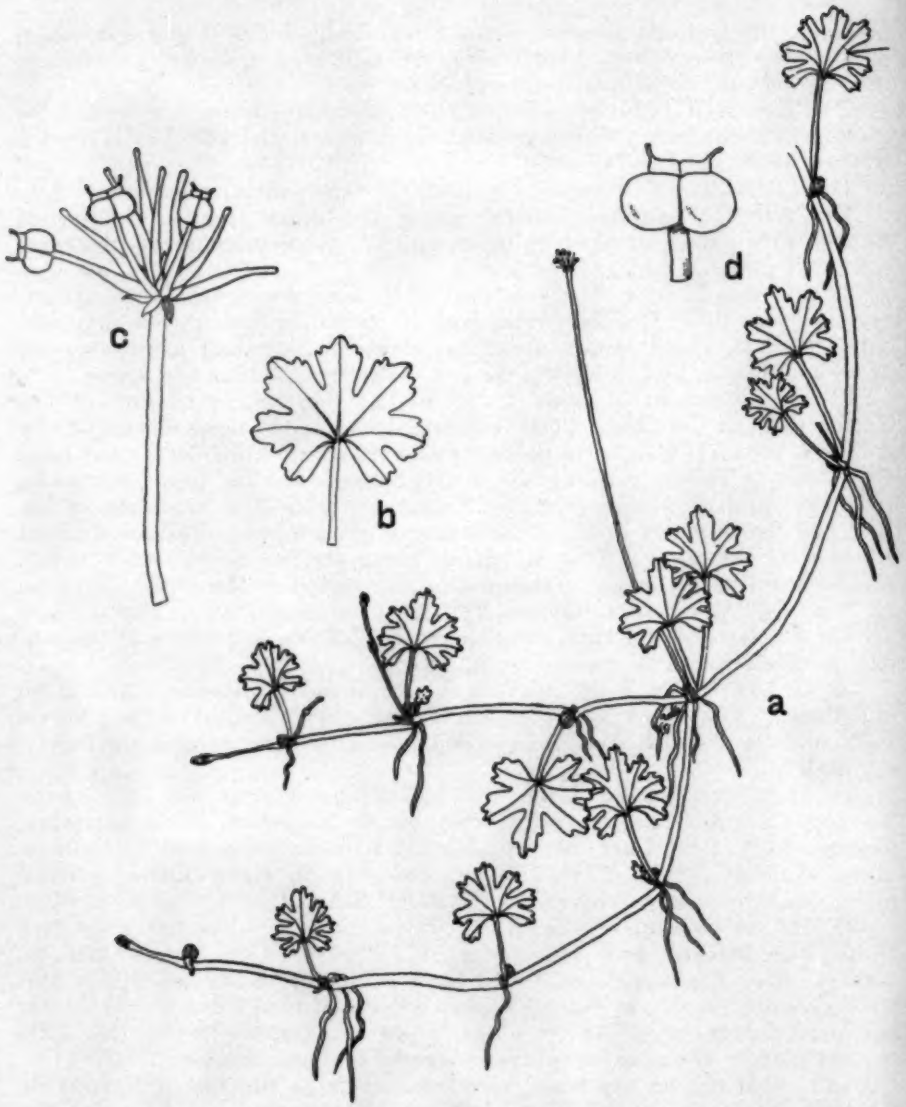


FIG. 3. *Hydrocotyle Cuatrecasasii*. a. Habit, ×2. b. Foliage leaf, ×2¼. c. Umbellet, ×8½. d. Mature fruit, ×8½.

5–7-lobed one-third to half the distance to the petiole, the lobes rounded to truncate, 3–5-lobulate, the petioles slender, 2–12 cm. long, crispate-hirsute especially above; peduncles longer than the leaves, 2–4 cm. long, crispate-hirsute especially above; umbels simple, 9–14-flowered, the pedicels slender, about 2 mm. long, spreading and reflexed, glabrous; fruit transversely elliptical, about 1 mm. long, 1.5–2 mm. broad, glabrous, the ribs evident, acute, the stylopodium depressed.

TYPE SPECIMEN: *Cuatrecasas 8554*, Quebrada del río Hacha, abajo de Gabinete, Cordillera Oriental, vertiente oriental, Comisaría del Caquetá, Colombia, altitude 2100–2250 m., 23 March, 1940. (UC 753628.)

DISTRIBUTION: Known only from the type collection.

COLOMBIA: Caquetá: Quebrada del río Hacha, *Cuatrecasas 8554* (UC: type, LA, US).

In Dr. Mathias' key (p. 204) this would fall between *H. Pennellii* Rose and *H. incrassata* R. & P. It differs from the former in its more deeply lobed leaves, crispate-hirsute rather than soft-puberulent leaves and petioles, peduncles longer than the leaves, fewer flowers, shorter pedicels, and smaller fruit. From *H. incrassata*, the new species is distinguished by its pubescence, deeper leaf-lobing, and unthickened leaf margins.

38. H. INCRASSATA R. & P. COLOMBIA: Cauca: Cordillera Central, vertiente occidental, Cabeceras del río Páez, páez, páramos entre Perro Muerto y la Laguna del Páez, 3550–3450 m., *Cautrecasas 19028* (F, GH, UC); Cordillera Central, vertiente oriental, región de Moscopán, Chorrera de Candelaria, 2100–2350 m., *Cuatrecasas 23591* (UC). El Valle: Cordillera Central, vertiente occidental, Cabeceras del río Tuluá, Quebrada de Las Vegas, páramo, 3400–3500 m., *Cuatrecasas 20382* (Fac. Agron. del Valle); Cordillera Central, vertiente occidental, Hoya del río Bugalagrande, Barragán, Páramo de Bavaya, 3680–3600 m., *Cuatrecasas 20066* (F). ECUADOR: Azuay: along the río Cumbe (25–30 km. south of Cuenca, 10,000 feet, scrambling on banks, perianth yellowish, in the subpáramo chaparral, *Camp E-2056* (NY, UC); Eastern Cordillera, 1–8 km. north of the village of Sevilla de Oro, 8000–9000 feet, plants in clumps from subterranean rhizome, perianth pale greenish-yellow, *Camp E-4313* (NY, UC). This species has been poorly known, and material had been recorded only from Chimborazo, Ecuador, and La Paz, Bolivia. These collections establish it as a well-defined species and extend its range into the Central and Eastern cordilleras of Colombia.

DIVISION OF BOTANY, UNIVERSITY OF CALIFORNIA
LOS ANGELES, CALIFORNIA
DEPARTMENT OF BOTANY, UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, PP. 310–321 JULY, 1951

THE OCCURRENCE OF ANTIBACTERIAL SUBSTANCES IN SEED PLANTS WITH SPECIAL REFERENCE TO MYCOBACTERIUM TUBERCULOSIS[1]

E. H. LUCAS[2], ARDETH LICKFELDT[2], R. Y. GOTTSHALL[3], AND J. C. JENNINGS[3]

In an earlier paper (Gottshall, Lucas, Lickfeldt and Roberts 1949) the results of screening of plant materials for activity against *M. tuberculosis* during a period of approximately one year were reported. This sequel presents the results of another year's work.

Methods. Preparation of plant materials and bacteriological testing generally proceeded along the lines described in the first publication. In view of the wide differences in texture, moisture content and chemical composition of the plant materials used it was never attempted to obtain the information desired for purposes of comparison, much less as a quantitative measure of activity. A screening program like the one described serves merely the purpose of providing leads which if sufficiently promising must be pursued in specialized studies of the particular plants. Dry matter determinations of the plant materials tested which could have been used as a common denominator in estimating relative potency of the extracts were therefore considered to be unnecessary at this point of the investigation.

Most of the crude materials were used in a fresh state soon after collection. The water and ethanol extracts of fresh materials were prepared in a Waring Blendor at the ratio of one part by weight of plant material and three parts of solvent. Hot water extraction took place by placing the finely cut material in boiling water at the same ratio. Water lost by boiling was replaced. Partly or completely dehydrated materials were prepared in amounts of solvents comparable to the ones used for the preparation of fresh extracts.

In addition to *M. tuberculosis*, strain H37, three other microorganisms, namely *Staphylococcus aureus*, F. D. A. strain 209P, *Salmonella typhimurium*, Edwards strain 9, and *Escherichia coli*, M. D. H. SA436, were subjected to the extracts in order to broaden the scope of information. One of the main reasons for using these three organisms was to determine the degree of specificity of the crude extracts.

Aqueous extracts were adjusted to pH 6.5 to 7.0 with sodium hydroxide. Cold water extracts were sterilized by filtration through Seitz filter sheets and hot water extracts by autoclaving at 121° C for 15 minutes.

[1] Journal Article No. 1172 from the Michigan Agricultural Experiment Station. This research was in part supported by the Horace H. Rackham Research Endowment.

[2] Department of Horticulture, Michigan State College, East Lansing, Michigan.

[3] Division of Laboratories, Michigan Department of Health, Lansing, Michigan.

To determine whether the extracts inhibited the growth of the tubercle bacillus, serial two-fold dilutions were prepared in screw-capped tubes using saline for a diluent. Liquefied glycerol beef extract agar, pH 7.0 was then added. The agar was allowed to harden in a slanting position and after solidification the surface was inoculated with a 15-to-21-day-old culture of *M. tuberculosis*, strain H37, grown on Petragnani's medium. After incubation for six weeks at 37° C the tubes were examined. The highest dilution in which no growth occurred was considered the titer of the extract. Those extracts found to be inhibitory were retested to determine whether their activity was influenced by blood. In this case the test was repeated using glycerol beef extract agar as well as glycerol beef extract agar to which 10 per cent of sheep blood had been added.

The antibacterial activity of the extracts toward *Staph. aureus*, *S. typhimurium* and *E. coli* was determined in the following manner. Broth, (F.D.A. formula) pH 7.0 was inoculated with one per cent of an 18-to-24-hour culture of the organism and two-fold dilutions of the extract made with 2.0 ml. volumes of the seeded broth. The cultures were observed after incubation for 24 and 48 hours at 37° C and the highest dilution showing complete inhibition of growth was considered the titer of the extract.

With some extracts, a precipitate formed when broth and extract were mixed. If the precipitate interfered with reading the tests, serial dilutions of extract and uninoculated broth were prepared, centrifuged, the supernatant removed and inoculated with a loopful of a 24-hour culture of the organism. Another method used to determine whether growth occurred in the presence of those extracts which precipitated when added to broth was to add an indicator. One-tenth ml. of 0.04 per cent alcoholic bromcresol purple indicator was added to each tube after 24 hours of incubation and the highest dilution in which no fermentation occurred was considered the titer of the extract.

Results and discussion. Table 1 produces the results in a semiquantitative manner. Although the original classification, based on "Die natürlichen Pflanzenfamilien" by Engler and Prantl, was followed throughout the tabulation, the families appear in alphabetic order to facilitate looking up information. Only species showing activity are represented in the table. Extracts of parts tested of the following species were negative against any of the test organisms:

Abutilon abicennae
Achillea Millefolium
Achimenes grandiflora
Adonis vernalis
Aesculus parviflora
Agapanthus umbellatus
Ageratum Houstonianum
Alternanthera vericolor
Althaea rosea
Alyssum maritimum
Anethum graveolens
Apium graveolens

Artemisia absinthium
Asparagus Sprengeri
Aspidistra lurida
Beloperone guttata
Bougainvillia glabra
Brassica campestris, var. *Napo-Brassica*
Brassica oleracea, var. *capitata*
Brassica oleracea, var. *sabauda*
Bromus inermis
Calendula officinalis
Calendula suffruticosa
Calla palustris
Callistephus hortensis
Canna compacta
Capsella bursa-pastoris
Celosia argentea
Centaurea Cyanus
Cichorium Endivia
Citrus nobilis
Cleome spinosa
Clerodendron Thomsonae
Convallaria majalis
Convolvulus repens
Cucumis sativus
Cyperus alternifolius
Delphinium formosum
Dianthus barbatus
Dianthus Caryophyllus
Dianthus deltoides
Dieffenbachia picta
Echium vulgare
Eschscholtzia californica
Euphorbia Cyparissias
Evonymus europaea
Filipendula rubra
Gladiolus species
Gleditsia triacanthos
Hedera helix
Hyssopus officinalis
Ipomoea purpurea
Juglans nigra
Kniphofia Uvaria
Kochia Childsii
Lactuca sativa, var. *capitata*
Lactuca sativa, var. *intybacea*
Lamium maculatum
Lathyrus odoratus
Lespedeza cuneata
Lespedeza hedysaroides
Lilium speciosum
Lonicera Maackii
Lonicera tatarica
Lysimachia vulgaris
Matthiola incana
Medicago sativa
Mentha piperita
Mesembryanthemum cordifolium
Monarda festulosa
Musa sapientum
Narcissus poeticus
Narcissus Pseudo-Narcissus
Nemophila insignis
Ornithogalum thyrsoides
Oxalis acetosella
Pereskia aculeata
Petroselinum hortense
Phaseolus lunatus
Phaseolus vulgaris
Portulaca oleracea
Pyrostegia venusta
Raphanus sativus
Ricinus communis
Rosa alba
Rosa blanda
Rosa cariifolia
Rosa humilis
Rosa setigera
Rudbeckia laciniata
Rumex acetosella
Saintpaulia ionantha, var. *grandiflora*
Sanchezia nobilis
Sanguisorba officinalis

Sansevieria zeylanica
Saponaria officinalis
Scilla bifolia
Senecio cruentus
Senecio mikanioides
Solanum Dulcamara
Statice elata
Stellaria media
Strobilanthes isophyllos
Symphoricarpos albus
Taraxacum officinale
Thymus vulgaris
Tillandsia utriculata
Trifolium minus
Triticum vulgare
Vinca major
Viola tricolor
Wisteria sinensis

The following tables (2 and 3) analyze the results recorded in table 1. It was of interest to see whether the activity in plant extracts against *M. tuberculosis* would occur at approximately the same rate of frequency as in the first testing period. Table 2 shows that during the first period 16.7% of the species exhibited some degree of activity against *M. tuberculosis* in one or more of the plant parts tested. In the second period the percentage increased to 21.2. Similarly, the percentage of those species which produced preparations with specific activity against *M. tuberculosis* was 8.7 in the first period as compared with 9.5 in the second period.

Table 3 attempts the grouping of tuberculostatic activity according to the plant organs from which the preparations were made. At this time a survey of such a nature cannot be considered to have any but preliminary significance. A much larger number of plant materials will have to be examined, and the use of various solvents must be employed before conclusions can be drawn from this kind of tabulation. However, the present attempt will indicate the direction which further work is scheduled to follow. Activity occurred most frequently in flowers (17.9%) and in leaves (17.3%) and was found least frequently in fruits (3.2%) and seeds (7.1%). This table does not take into account the results obtained in the first test period. A comparison with these preliminary results may be of interest. Of 27 species showing activity against *M. tuberculosis* during the first period 9 showed activity in the leaf extracts. In five cases it was found in the extract of leaves and flowers combined, while flowers alone showed activity only in three cases. In five plants the activity was found in the roots. No activity was recorded in seeds and fruits. Of 42 species tested during the second year 24 showed activity in leaves, 14 in flowers, 6 in roots, and only 2 in seeds and fruits.

As in the first test period, the active principle of only one of the species tested retained its potency in the presence of whole blood.

Experience gained during these two years of investigating plant materials has shown that the separation of plants into organs may not suffice to trace antibacterial activity successfully. In several instances organs were therefore divided into parts. Some of the species had been previously tested

TABLE 1. *Activity of plant extracts against M. tuberculosis and other microorganisms*

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Aceraceae					
Acer ginnala	L	B+	B+	B+	–
	St	–	B+	C++	–
	Se	–	B+	–	–
Amarantaceae					
Iresine Herbstii	L	–	B+	–	–
	St	B+	–	–	–
	R	–	B+	–	–
	Fr	–	B+	–	–
Amaryllidaceae					
Hymenocallis Macleana	L	B+	–	–	–
	R	–	–	–	–
	Bu	B+	–	–	–
Anacardiaceae					
Cotinus Coggygiea	L	–	B+	–	–
	St	–	C++	–	–
	Fl	–	B+, C++	–	–
Apocynaceae					
Nerium Oleander	L	A+	–	–	–
	St	–	–	–	–
	Fl	–	–	–	–
Araceae					
Aglaonema pictum	L	–	B+	–	–
	St	–	–	–	–
	Fl	–	–	–	–
Monstera deliciosa	L	–	C++	–	–
	St	–	–	–	–
	Fl	–	C++	–	–
	Fr	–	–	–	–
Pothos aureus	L	–	B+	–	–
	St and R	–	–	–	–
Spathiphyllum cannaefolium	L	–	B+	B+	–
	R	–	–	–	–
	Fl	–	–	–	–
Aristolochiaceae					
Aristolochia Clematitis	L	B+	B+	–	–
	St	–	–	–	–
Balsaminaceae					
Impatiens pallida	L	–	–	–	–
	St	–	–	–	–
	R	B+	–	–	–
Begoniaceae					
Begonia Dregei × *B. socotrana*	L	–	–	B+	–
	St	–	B+	–	–
	R	–	–	–	–
Bignoniaceae					
Catalpa speciosa	L	–	–	–	–
	St	–	–	–	–
	Se	–	–	–	–
	Pod	–	A+	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Buxaceae					
Buxus sempervirens	L	C+++	–	–	–
	St	–	–	–	–
Caprifoliaceae					
Viburnum Opulus	L	–	B+	B+	–
	St	–	–	–	–
	Fr	–	B+	B+	–
Compositae					
Antennaria margaritacea	E	–	B+	–	–
Chrysanthemum cinerariaefolium	Fl	B+	–	–	–
Chrysanthemum segetum	L	B++, C+++	–	–	–
	St	B+	–	–	–
	Pt	A+, B+	B+	–	–
	Ca	A+, C+++	–	–	–
Gaillardia pulchella	L	–	B+	–	–
	St and R	–	–	–	–
Helichrysum coronarium	L	–	B+	–	–
	St	–	–	–	–
	R	–	B+	–	–
Lonas inodora	L	–	–	–	–
	St and R	B+	–	–	–
Petasites japonicus	L	–	C++	–	–
	St	–	–	–	–
	R	C+++	B+, C++	–	–
Santolina Chamaecyparissus	L and Fl	–	B+	–	–
	R	C+++	–	–	–
Silphium laciniatum	L	–	–	–	–
	St	–	–	C++	–
	Fl	–	–	–	–
Solidago canadensis	L	–	–	–	–
	St	–	–	–	–
	Fl	–	C++	–	–
Tagetes patula	L	–	–	–	–
	St	–	–	–	–
	R	–	–	–	–
	Fl	–	B+	–	–
Crassulaceae					
Bryophyllum pinnatum	L	–	B+	–	–
	St	–	B+	–	–
	R	–	–	–	–
Cruciferae					
Barbarea vulgaris	L	–	–	–	–
	St	–	–	–	–
	R	–	–	–	–
	Fl	C+++	–	–	–
Berteroa incana	L	–	A+	–	–
	St	–	A+	–	–
	R	–	–	–	–
	Fl	–	A+	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Brassica oleracea, var. *botrytis*	L	–	–	–	–
	St	–	–	–	–
	Curd	–	–	–	A+
Dipsacaceae					
Scabiosa atropurpurea	L	–	–	–	–
	St	B+	B+	–	–
	Fl	–	–	–	–
Ericaceae					
Rhododendron indicum	L and Fl	–	B+	–	–
	St and R	–	–	–	–
Euphorbiaceae					
Acalypha hispida	L and Fl	–	B+	–	–
	St	–	B+	B+	B+
	R	–	B+	–	–
Acalypha Wilkesiana	L	–	B+	–	–
	St and R	–	B+	–	–
Codiaeum variegatum	L	A+	–	–	–
	St	A+	–	–	–
Euphorbia pulcherrima	L	–	–	–	–
	St	–	B+	–	–
	Fl	–	–	–	–
Geraniaceae					
Pelargonium domesticum	L	–	B+	–	–
	St and R	–	–	–	–
	Fl and Ped	–	A+, B++	B+	B+
Labiatae					
Teucrium Chamaedrys	E	C+++	–	–	–
Leguminosae					
Baptisia tinctoria	L	B+	B+, C++	–	–
	St	–	–	–	–
	Se	–	–	–	–
Caragana microphylla	L	A+	–	–	–
	St	–	–	–	–
	Se	–	–	B+	–
Cercis canadensis	L	–	–	–	–
	St	–	–	–	–
	Se	–	A+, B+	–	–
Lupinus hirsutus	L	B+	–	–	–
	St	–	–	–	–
	R	C+++	–	–	–
	Fl	B+	–	–	–
Lupinus polyphyllus	L and St	B+, C+++	B+	–	–
	R	C+++	A++, C++	–	–
Mimosa pudica	L	B+	B+	–	–
	St	–	–	–	–
	R	–	B+	–	–
	Fl	–	–	–	–
Robinia Pseudacacia	L	–	B+	–	–
	St	–	B+	C++	–
	Fl	–	–	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Vicia Cracca	L	A+, B+	–	–	–
	St	–	–	–	–
Liliaceae					
Lilium Harrisii	L	A+	–	–	–
	St	–	–	–	–
	R	–	–	–	–
	Fl	–	–	–	–
	Bu	–	–	–	–
Tulipa acuminata	Pt	–	A+	A+	A+
Tulipa Gesneriana	L	A+	A+, B+, C++	A+, B+, C++	A+, B+, C++
	St	B+	A+, B+	A+, B+	A+, B+
	Bu	–	–	–	–
	Pt	A+, B+	A+, B+, C++	A+, B+, C++	A+, B+
	Ca	A+	A+	A++, C++	A+
Linaceae					
Linum flavum	L	–	–	–	–
	R	–	B+	–	–
Malvaceae					
Napaea dioica	L	–	–	–	–
	St	–	B+	–	–
Oleaceae					
Fraxinus excelsior	L	B+	–	–	–
	St	–	–	–	–
	Se	–	–	–	–
Ligustrum vulgare	L	–	A+	–	–
	St	–	–	–	–
Syringa vulgaris	L	C+++	B+	–	–
	St	B+	–	–	–
	Fl	C+++	–	–	–
	Fr	–	–	–	–
Onagraceae					
Clarkia elegans	L and Fl	–	B+	–	–
	St and R	–	B+	–	–
Fuchsia speciosa	L	–	–	–	–
	St and R	–	B+	–	–
	Fl	–	B+	–	–
Palmaceae					
Phoenix dactylifera	L	–	B+	–	–
	St	–	B+	–	–
Papaveraceae					
Bocconia cordata	L	–	B+, C++	–	–
	St	–	C++	–	–
	Fl	B+	C++	–	–
Chelidonium majus	L	–	–	–	–
	St	–	–	–	–
	R	–	C++	–	–
Phytolaccaceae					
Phytolacca americana	L	–	–	–	–
	St	–	–	–	B+
	Fl	–	–	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Polygonaceae					
Polygonum sachalinense	L	–	B+	–	–
	St	–	B+	–	–
Primulaceae					
Cyclamen persicum	L	–	B+	–	–
	R	–	–	–	–
	Fl	–	–	–	–
Primula malacoides	L	–	–	–	–
	R	–	–	–	–
	Fl and Ped	B+, C+++	C++	–	–
Primula obconica	L	–	B+	–	–
	St	–	–	–	–
	Fl	–	B+	–	–
Proteaceae					
Gravillea robusta	E	–	B+	–	–
Ranunculaceae					
Anemone canadensis	L	–	–	–	–
	St	–	–	–	–
	R	–	–	–	–
	Se	B++	–	B+	B+
Rosaceae					
Cotoneaster acuminata	L	–	–	–	–
	St	–	–	–	–
	Fr	–	B+	–	–
Crataegus monogyna	L	–	–	–	–
	St	–	B+	–	–
	Fr	–	–	–	–
Crataegus Oxyacantha	L	–	B+	–	–
	St	–	–	–	–
	Fr	–	B+	–	–
Pyracantha coccinea	L	–	B+	–	–
	St	–	–	–	–
	Fr	–	–	–	–
Pyrus atrosanguinea	L	C+++	–	–	–
	St	–	–	–	–
	Fr	B+	B+	B+	B+
Rosa canina	L	B+, C+++	B+	B+	–
	St	C+++	–	–	–
	Fl	C+++	B++	–	–
	Fr	–	–	–	–
Rosa multiflora	L and St	–	B+	–	–
	Fl	B+	B+	–	–
	Fr	–	–	–	–
Sanguisorba tenuifolia	L	–	–	C++	–
	St	–	–	–	–
	Fl	–	–	–	–
Rubiaceae					
Hoffmannia Ghiesbreghtii	L	–	B+	–	–
	St	–	–	–	–
	R	–	–	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Rutaceae					
Correa pulchella	L	–	–	–	–
	St	–	B+	–	–
Ptelea trifoliata	L	A+	–	–	–
	St	–	–	–	–
	Fr	–	–	–	–
Ravenia humilis	L	B+	–	–	–
	St	–	–	–	–
	R	–	–	–	–
Salicaceae					
Salix Caprea	Fl	C+++	–	–	–
Saxifragaceae					
Hydrangea arborescens	L and St	–	–	–	–
	R	B+	–	–	–
	Fl	–	–	–	–
Saxifraga sarmentosa	E	–	B+	–	–
Scrophulariaceae					
Antirrhinum majus	L	–	–	–	–
	St and R	–	–	–	–
	Pt	–	–	–	–
	Ca	C+++	–	–	–
Linaria vulgaris	L and Fl	–	A+	–	–
	St and R	–	–	–	–
Pentstemon grandiflorus	L and Fl	–	–	–	–
	St and R	–	A+	–	–
Solanaceae					
Datura cornigera	L	–	–	–	–
	St	–	–	–	–
	Fl	–	C++	–	–
	Fr	–	–	–	–
Taxaceae					
Taxus canadensis	L	A+, B+, C+++	–	–	–
	St	–	–	–	–
	Fr	–	–	–	–
Umbelliferae					
Aegopodium Podograria	L	–	C++	–	–
	St	–	B+	–	–
	R	–	C++	–	–
Urticaceae					
Boehmeria argentea	L	–	B+	–	–
	St	A+	–	–	–
Verbenaceae					
Lantana Camara, var. *mutabilis*	L, St and R	–	B+	–	–
	Fl	–	–	–	–
Verbena erinoides	L	A+	–	–	–
	St	–	–	–	–
	R	–	–	–	–
	Fl	–	–	–	–

Plant name	Plant part	Result			
		M. tuberculosis	Staph. aureus	S. typhimurium	E. coli
Vitaceae					
Parthenocissus tricuspidata	L	–	B+	–	–
	St	–	B+	C+	–
	Fr	–	B+	B+	–
Vitis Labrusca	Se	–	A+, B+	–	–
	Fr	–	B+	B+	B+

Activity is indicated by + (active in dilutions below 1: 20), ++ (active in dilutions between 1: 20 and 1: 80), or +++ (active in dilutions above 1: 80). A, B, or C preceding these signs indicates cold water, boiling water, or ethanol extract respectively. Lack of activity is signified by –.

Plant parts are abbreviated as follows: bulb, Bu; calyx, Ca; entire plant, E; flower, Fl; fruit, Fr; leaf, L; peduncle, Ped; petal, Pt; root, R; seed, Se; stem, St.

TABLE 2. *Frequency of occurrence of activity against M. tuberculosis in plant species tested during two consecutive years.*

	Species tested	Activity against *M. tuberculosis* linked with activity against other bacteria	Specifically active against *M. tuberculosis*	Total number active against *M. tuberculosis*
First Year	161	14	13.	27
Second Year	199x	23	19	42
Total	360	37	32	69

X Actual number tested was 202, but 3 species had been tested for activity of other plant parts in first year.

TABLE 3. *Distribution of activity against M. tuberculosis in plant organs*

Plant organ	Samples tested	Active against *M. tuberculosis*	Percentage of active samples
Leaves	139	24	17.3
Stems	110	8	7.3
Flowers	78	14	17.9
Roots	56	6	10.7
Fruits	31	1	3.2
Seeds	14	1	7.1
Other parts	77	4	5.2

for activity in certain organs while other organs had been omitted, mostly because of unavailability of them at the time of testing. These gaps have been closed partially; others are still open. It is evident, however, from the work so far done that a reliable description of the antibacterial properties

of higher plants cannot be given without information on the response of extracts of every specialized part of the plant. This will undoubtedly lead to an investigation into tissues rather than organs. It is realized also that the means of extraction have not been exhausted; the use of a variety of solvents, in some cases to extract the active principle, in others to eliminate interfering factors, is an essential requirement. If this requirement has not been met, or only incompletely, in the present study, it was because of lack of means for the accomplishment of an extremely time-consuming work, not because of failure to realize its importance.

SUMMARY

1. Results obtained during the second year of screening of extracts of seed plants for presence of substances antagonistic to *M. tuberculosis*, are presented.

2. Species belonging to 87 families were tested during two consecutive years. Seventy-one families appear in the test covered by the present report, 37 of which had representatives in the first year's test. The total number of species investigated in two years is 360; the second testing period, analyzed in this paper, includes 199 of them.

3. Forty-two species were found to contain principles controlling the growth of *M. tuberculosis*, 19 of which had specific activity. Antibacterial action against *Staph. aureus*, *S. typhimurium*, and *E. coli* was also recorded.

Department of Horticulture, Michigan State College
East Lansing, Michigan
Division of Laboratories, Michigan Department of Health
Lansing, Michigan

Literature Cited

Gottshall, R. Y., Lucas, E. H., Lickfeldt, A., and Roberts, J. M. 1949. The occurrence of antibacterial substances active against *M. tuberculosis* in seed plants. Jour. Clin. Investig. **28**: 920–23.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, PP. 322–323 JULY, 1951

THE ARITÚ OR LOURO ARITÚ, A NEW SPECIES OF TIMBER TREE FROM THE BRAZILIAN AMAZON.

A. DUCKE

Licaria aritu sp. nov. A speciebus affinibus *L. Appelii* (Mez) Kostermans et *L. Duartei* Allen, Brasiliae silvas montanas meridionales subtropicales inhabitantibus, divergit foliorum pagina inferiore glabra vel pilis minimis conspersa, florum receptaculo staminibus et ovario glabris, corticis et alburni odore grato benzoë odorem aliquanto imitante. Arbor ad 30 m. alta ligno brunneo, duro, resistente. "Aritú" vel "louro aritú" appellatur.

Sat frequens in silva primaria non inundabili civitatis Amazonas parte centrali et orientali. Specimina examinata: Ducke Jard. Bot. Rio 23979 at cum ligno 215 in Yale, Manaus 15-VI-1932, speciei typus; Ducke J.B.R. 4664, Maués 7-X-1929; Ducke J.B.R. 23978, Parintins 26-VIII-1932; omnia florifera. Specimen fructiferum Krukoff 6900, Livramento prope flumen Madeira, vidi in herbario J.B.R.

This new species represents the "aritú" or "louro aritú," one of the most esteemed timber trees of Manaus, formerly frequent in the upland rain forest around the city. Its wood is one of the best among the several species of "louro" here employed in constructions. The glabrous or subglabrous leaves and flowers as well as the agreeable somewhat benzoe-like odor of the inner bark and alburnum distinguish it from its above cited Southern congenerics.

Kostermans in "Revision of the Lauraceae" cites Ducke lig. 215 under *L. Appelii*, together with Robert 617 from S. Ana da Chapada, Mato Grosso. "These two specimens are less densely sericeous on the lower leaf surface as the type specimen; the flowers are identical. The specimen Krukoff 6900, cited under *L. multiflora* in Rec. Trav. Bot. Néerl, 33 p. 736 belongs to *L. Appelii*" (Rec. Trav. Bot. Néerl, 34 p. 601). The author of that otherwise very valuable monograph worked only with herbarium specimens and did not remind that a tree of the equatorial rain forest could hardly be conspecific with one tree growing on the subtropical mountains with winter temperatures below zero. Unfortunately, no comparative study has till now been made of the wood of these trees.

In accordance with Kostermans, Record and Hess refer to the aritú as *L. Appelii*. "The Aritú or louro aritú of the lower Amazon region, *L. Appelii* (Mez) Kosterm., occurs also in Mato Grosso and Minas Gerais, Brazil. The tree attains rather large size and yields a lustrous brown more or less streaked, hard, strong, and durable timber suitable for furniture and heavy construction." Record and Hess, Timbers of the New World, p. 208. The

wood sample here referred to is Ducke lignum 215, from the type tree of *L. aritu* n. sp.

I am not able to decide whether the recently described *L. Duartei* Allen, Tropical Woods 78: 4 (1944) would differ from *L. Appelii* whose type came from Biribirí near Diamantina, Minas Gerais. I did not see that type; I saw, however, C. Porto Jard. Bot. Rio 11070, from Itatiaia, attributed by Kostermans to the same *L. Appelii* but with certainty conspecific with *L. Duartei*. I examined several collections of these Itatiaia trees: besides the already cited, J.B.R. 2143, 2248 and 46425 (= Col. Itatiaia 1429). All have leaves covered beneath with ferruginous or cinnamon colored pilosity, and pilose receptacle, stamens and ovary.

RUA PACHECO LEAO 987
GAVEA, RIO DE JANEIRO

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, PP. 324–330 JULY, 1951

A STUDY OF THE CHROMOSOME MORPHOLOGY OF SOME SPECIES OF TRILLIUM

PAUL C. BAILEY

In recent years numerous papers have been published in the field of cytotaxonomy which have been concerned with the cytological aspects of certain species of *Trillium*. A number of papers have attempted to establish differences between closely related species on the basis of visible differences in their chromosome morphology, the usual criteria of difference being the total length of the chromosomes and the relative length of the chromosome arms.

Haga (1934) concluded from his studies of *Trillium kamstchaticum*, *Trillium smallii* and *Trillium tschonoskii* that, "it is hardly tenable to consider the slight difference in length and form per cents in absolute lengths of the chromosomes found between different species as being significant". Barksdale (1938), as a result of his studies of the pedicellate species of *Trillium* from the southern Appalachians, states "that such an attitude, which seems to result from the assumption that such minor floral and vegetative variations peculiar to any one species will be reflected in the morphology of one or several of the chromosomes of the species complement, is, at least, in the case of *Trillium*, a rather naive one."

It was the purpose of this study to determine whether there exists any variations between the chromosome morphology of several of the sessile species of *Trillium* found in the southeastern United States, and, if any variations do occur, whether these are sufficient to separate species or to make groupings of species. The criteria used were those which had been employed previously by other investigators, that is, the total length of the normal chromosome complement, the total length of the individual chromosomes, and the relative length of the chromosome arms.

Materials and methods. Five different species of *Trillium* were used in this study. Rhizomes were collected from various localities suggested by Mr. Stanley J. Smith, Office of the New York State Botanist, and identification was made in the field using a key furnished by Mr. Smith. The rhizomes were potted in peat moss and fresh growing tips were used. *Trillium decumbens* Harbison was collected from Blount County Alabama, *Trillium lancifolium* Raf. from Tuscalloosa County Alabama, *Trillium sessile* L. from Shelby County Alabama, and *Trillium recurvatum* Beck and *Trillium stamineum* Harbison from Cullman County Alabama.

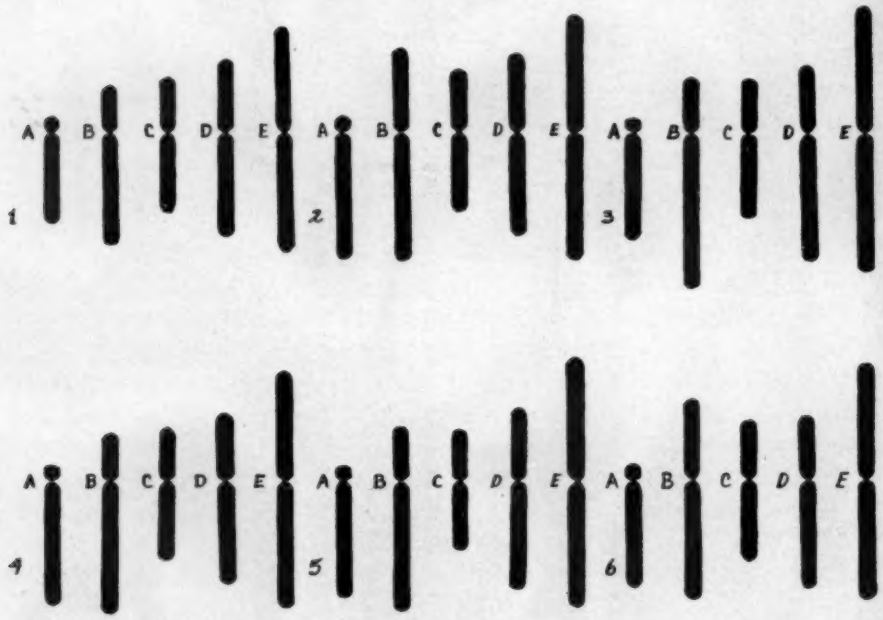
TABLE 1. *Comparative data on chromosome morphology of some species of Trillium*

Species	Chromosome																Total
	A			B			C			D			E				
	L.	S.	T.	L.	S.	T.	L.	S.	T.	L.	S.	T.	L.	S.	T.		
1. *T. decumbens* Harbison	9.3	1.6	11.0	11.6	4.9	16.6	8.3	5.8	14.1	10.9	7.3	18.2	12.0	11.2	23.2		166.4
2. *T. lancifolium* Raf.	13.2	1.6	14.9	13.6	8.4	22.1	8.3	6.6	14.9	10.7	8.3	19.0	13.2	12.1	25.4		192.9
3. *T. luteum* (Muhl.) Harbison	11.2	1.5	12.7	16.1	5.8	21.9	8.7	5.7	14.4	13.3	7.0	20.3	14.4	13.1	27.5		193.6
4. *T. sessile* L.	12.8	1.6	14.5	12.7	5.1	17.8	8.3	5.7	14.0	10.6	7.1	17.8	13.0	11.6	24.6		177.9
5. *T. recurvatum* Beck	12.0	1.6	13.7	13.2	5.8	19.1	7.1	5.3	12.5	11.1	7.4	18.6	13.3	12.7	26.0		180.1
6. *T. stamineum* Harbison	11.0	1.6	12.7	12.2	8.4	20.6	8.3	6.1	14.4	10.9	6.7	17.6	12.3	12.1	24.4		179.9

L.—Long Arm; S.—Short Arm; T.—Total Length.

All material for study was prepared using the Feulgen technique together with a squash method (Woodward 1948). Measurements were made with an ocular micrometer.

Observations and discussions. The morphology of the normal chromosome set of *Trillium decumbens* Harbison, *Trillium lancifolium* Raf., *Trillium sessile* L., *Trillium recurvatum* Beck, and *Trillium stamineum* Harbison was carefully studied. Data on *Trillium luteum* (Muhl.) Harbison



FIGS. 1–6. Diagramatic analysis of chromosome morphology of several sessile species of *Trillium*. FIG. 1. Normal chromosome set of *T. decumbens* Harbison. FIG. 2. Normal chromosome set of *T. lancifolium* Raf. FIG. 3. Normal chromosome set of *T. luteum* (Muhl.) Harbison. FIG. 4. Normal chromosome set of *T. sessile* L. FIG. 5. Normal chromosome set of *T. recurvatum* Beck. FIG. 6. Normal chromosome set of *T. stamineum* Harbison.

All figures are drawn to scale at an approximate magnification of ×1240 after reduction.

(Bailey 1949) was included for purposes of comparison. Measurements were made of more than 50 chromosomes of each type (A, B, C, D, and E) in the 2n root tip complement. The results of these measurements are summarized in table 1. The total length of the chromosome set as well as the length of the individual chromosomes and the length of the chromosome arms are shown for each species.

Diagrams showing the comparative length of the individual chromosomes of each species as well as the relative length of the chromosome arms are

given in figures 1, 2, 3, 4, 5, and 6. These reveal that the primary constriction of chromosome A is sub-terminal, that of B, C, and D is sub-median and that E has a slightly sub-median primary constriction for the chromosomes of all species studied.

The total length of the diploid chromosome set of the *T. sessile* L., *T. recurvatum* Beck, and *T. stamineum* Harbison was found to be very close, none of them differing by more than 2.2 microns. The total length of *T. sessile* L. was 177.9 microns, *T. recurvatum* Beck 180.1 microns, and *T. stamineum* Harbison 179.9 microns. This indicates that it would be almost impossible to separate these three species on the basis of the total length of their chromosomes. The total length of *T. lancifolium* Raf. was 192.9 microns while that of *T. luteum* (Muhl.) Harbison (Bailey 1949) was 193.6 microns. These are entirely too close to separate one from the other on this basis, but perhaps they could be separated as a group from the group composed of *T. sessile* L., *T. recurvatum* Beck, and *T. stamineum* Harbison. The two groups differ by approximately 13 microns. *T. decumbens* Harbison seems to be in a group by itself since it differs considerably in total length of the chromosomes from the two above mentioned groups. *T. decumbens* Harbison has a total length of 166.4 microns and could probably be separated from either of the other five species on this basis. It differs from *T. lancifolium* Raf. by 26.4 microns, *T. luteum* (Muhl.) Harbison by 27.1 microns, *T. sessile* L. by 11.4 microns, *T. recurvatum* Beck by 13.6 microns, and from *T. stamineum* Harbison by 13.4 microns. Difficulties might arise in trying to separate *T. decumbens* Harbison from *T. sessile* L., *T. recurvatum* Beck, and *T. stamineum* Harbison on this basis since variations in measurements might possibly cause *T. decumbens* Harbison to approach too closely the measurements of *T. sessile* L., *T. recurvatum* Beck, and *T. stamineum* Harbison; but the difference certainly seems sufficient between *T. decumbens* Harbison and *T. lancifolium* Raf. and *T. luteum* (Muhl.) Harbison.

A careful analysis of the total length of the individual chromosomes of each of the six species reveals one or two significant facts. The total length of chromosome A ranges from 11.0 microns in *T. decumbens* Harbison to 14.9 microns in *T. lancifolium* Raf. *T. luteum* (Muhl.) Harbison and *T. stamineum* Harbison approach more closely that of *T. decumbens* Harbison than any of the other species studied, their measurements being 12.7 microns and 12.7 microns respectively. *T. sessile* L. and *T. recurvatum* Beck show measurements which range between those of *T. luteum* (Muhl.) Harbison and *T. stamineum* Harbison and *T. lancifolium* Raf. This difference between the total length of chromosome A in *T. decumbens* Harbison and the other five species studied seems to be sufficient to separate it from the other species and is certainly noticeable in the study of the chromosome morphology of

the several species. This difference can be noted by comparing chromosome A in figures 1, 2, 3, 4, 5, and 6.

A comparison of the total length of chromosome B in the various species of *Trillium* is also worth noting (figs. 1, 2, 3, 4, 5, and 6). Chromosome B of *T. decumbens* Harbison is somewhat shorter than that of the other species, the total length being 16.6 microns. *T. lancifolium* Raf. shows a total length of 22.1 microns, *T. luteum* (Muhl.) Harbison 21.9 microns, *T. sessile* L. 17.8 microns, *T. recurvatum* Beck 19.1 microns, and *T. stamineum* Harbison 20.6 microns. The difference between the total length of chromosome B in *T. decumbens* Harbison and the other five species listed above would probably be of some significance in separating *T. decumbens* Harbison from the other species. The difference runs as high as 5.5 microns in the case of *T. lancifolium* Raf. and is very close to that in the case of *T. luteum* (Muhl.) Harbison and *T. stamineum* Harbison. The difference is somewhat less in the case of *T. sessile* L. and *T. recurvatum* Beck but still great enough to be of value. Difficulties might arise in separating *T. decumbens* Harbison from *T. sessile* L. on this basis since their total length differs by only 1.2 microns.

The total length of chromosome C, D and E of the various species is entirely too close to be of any significance as far as the separation of species is concerned.

TABLE 2. *Long-arm, short-arm, ratios in chromosomes of some species of Trillium*

Species	Chromosome				
	A	B	C	D	E
1. *T. decumbens* Harbison	17.7 : 100	42.8 : 100	70.0 : 100	67.4 : 100	93.1 : 100
2. *T. lancifolium* Raf.	12.5 : 100	62.2 : 100	80.0 : 100	77.3 : 100	91.5 : 100
3. *T. luteum* (Muhl.) Harbison	13.4 : 100	36 : 100	65.5 : 100	52.6 : 100	90.9 : 100
4. *T. sessile* L.	12.9 : 100	40.6 : 100	69.1 : 100	67.5 : 100	89 : 100
5. *T. recurvatum* Beck	13 : 100	43.9 : 100	75.2 : 100	67 : 100	95 : 100
6. *T. stamineum* Harbison	15 : 100	68.8 : 100	74.3 : 100	61 : 100	97.8 : 100

Table 2 shows the ratios of the chromosome arms, that is, the ratio of the length of the short arm to the length of the long arm. A careful analysis of this data reveals differences in chromosome morphology between species not shown in the total length of the chromosome complement or the total length of the individual chromosomes.

If the arm length ratios of chromosome A are observed it can be noted that the ratios of *T. lancifolium* Raf. (12.5 : 100), *T. luteum* (Muhl.) Harbison (13.4 : 100), *T. sessile* L. (12.9 : 100), and *T. recurvatum* Beck (13 : 100) are very close and would be of no value in separating these species. *T. decumbens* Harbison and *T. stamineum* Harbison show ratios which are slightly greater but would probably be too close to those listed above to be of great value.

The arm length ratio of chromosome B is almost the same in *T. decumbens* Harbison (42.8:100), *T. sessile* L. (40.6:100), and *T. recurvatum* Beck (43.9:100). The ratio of chromosome B in the case of *T. luteum* (Muhl.) Harbison (36:100) is slightly different from the above mentioned species. Perhaps the most noticeable difference however is in *T. lancifolium* Raf. (62.2:100) and *T. stamineum* Harbison (68.8:100).

The ratios in the case of chromosome C reveal nothing of great value for species separation. The ratios range from 65.5:100 in *T. luteum* (Muhl.) Harbison to 80:100 in *T. lancifolium* Raf. with the other four species ranging in between these two. If the species in question were at the extreme ends of this range perhaps the difference in ratios would be of sufficient value to be of help.

The ratios in chromosome D for *T. decumbens* Harbison (67.4:100), *T. sessile* L. (67.5:100), and *T. recurvatum* Beck (67:100) are very close. *T. stamineum* Harbison (61:100) differs slightly from this whereas *T. luteum* (Muhl.) Harbison shows a considerable variation, the ratio being 52.6:100. *T. lancifolium* Raf. shows a ratio indicating that its primary constriction is more median, the ratio being 77.3:100.

Chromosome E seems to reveal no evidence of difference in arm length ratios between the several species. *T. stamineum* Harbison shows a ratio of 97.8:100 whereas that of *T. sessile* L. is 89:100. Other species show ratios which range between these two. Again as in the case of chromosome C, species which have ratios at the extreme ends of this range might possibly be distinguished.

The fact that the total length of the chromosome complement of *T. lancifolium* Raf. differs from the total length of *T. recurvatum* Beck by 12.8 microns may be of some significance since some authorities (Fernald 1944) do not consider *T. lancifolium* Raf. as a true species but really *T. recurvatum* Beck. This difference in the total length of the two complements indicates that differences do exist between the two species as far as chromosome morphology is concerned. An analysis of the arm-length ratios also shows differences between the chromosome morphology of the two species. The long-arm, short-arm ratio of chromosome B for *T. lancifolium* Raf. is 62.2:100, whereas chromosome B in *T. recurvatum* Beck shows a ratio of 43.9:100. This difference in ratios is noticeable in figures 2 and 5.

SUMMARY

1. Certain species of *Trillium* may be grouped on the basis of the total length of their chromosome complements. Three groupings may be made of the six species included in this study. One group would be composed of *T. sessile* L., *T. recurvatum* Beck, and *T. stamineum* Harbison. Another group

includes *T. lancifolium* Raf. and *T. luteum* (Muhl.) Harbison while *T. decumbens* Harbison stands in a group to itself.

2. The above groups could possibly be separated one from the other on the basis of the total length of their chromosome complements, but it would be almost impossible to separate species within a group on this basis.

3. Total length of individual chromosomes offers little help in separating the six species included in this study; however, chromosomes A and B of *T. decumbens* Harbison are noticeably shorter than in the other five species studied. This difference would probably be sufficient to separate it from the other species mentioned.

4. A very careful analysis of the arm length ratios of individual chromosomes may reveal sufficient differences between particular species to separate them on this basis.

ALABAMA COLLEGE
MONTEVALLO, ALABAMA

Literature Cited

Bailey, Paul C. 1949. Differential chromosome segments in Trillium erectum L. Bull. Torrey Club. **76**: 319–336.

Barksdale, Lane. 1938. The pedicellate species of *Trillium* from the Southern Appalachians. Jour. Elisha Mitchell Soc. **54**: 271–296.

Fernald, M. L. 1944. Overlooked species, transfers and novelties in the flora of Eastern North America. Rhodora **46**: 541: 1–21.

Haga, T. 1934. The comparative morphology of the chromosome complement in the tribe Parideae. Jour. Fac. Sci. Hokkaido Im. Uaiv. Bot. **2**: 1–32.

Woodard, T. M. Jr. 1948. Some features of mitosis in the onion root tip. Jour. Tenn. Acad. of Sci. **23**: 191–199.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, PP. 331–349 JULY, 1951

STUDIES ON ANTHOCEROTALES. III[1]

JOHANNES PROSKAUER

4. The genera *Anthoceros* and *Phaeoceros*.

In a previous paper, dealing with European species (Proskauer, 1948a), it was pointed out, that the genus *Anthoceros* appeared to be composed of two elements markedly different from each other, but that an investigation of its many species would be necessary before a division could be firmly established. Since then I have been fortunate to be able to collect a considerable number of species of Anthocerotaceae in California, in Chile, and in the Amazonas territory of Perú. These species were observed not only in the field and from material preserved on the spot, but in addition all of them are being grown in culture. Also I have received for study material from New Zealand, Australia, and India, either in the living condition or well preserved. So far it has not proved possible to assign specific names to the bulk of these forms; it is my hope to treat of them individually in due course. But their generic alliances are clear. On the strength of the additional studies I venture now to take up the discussion of the genus *Anthoceros* L. (s.l., but excl. *Megaceros* Campbell, 1907) in more detail.

Gottsche (1858) subdivided *Anthoceros* into sections as follows:

A. Elateres fibra spirali depicti.
B. Elateres articulis elongatis sine fibra spirali.
C. Elateres cellulis justo paullo longioribus articulatim compositi.
   a. Superficie frondis in lobulos adventivos excrescente.
   b. Superficie laeviori, cavitates aereae fronde non praesentes.
   c. A. stoloniferi.

Campbell (1907) founded the genus *Megaceros* to include the species in section A. It will be shown below, that of the remaining species those in sections B and Ca (the latter including *A. punctatus* L., the lectotype of *Anthoceros;* cf. Linne, 1753; Gottsche et al., 1844; Proskauer, 1948a) appear closely allied and markedly opposed to the residue in Cb and Cc. This becomes clear from taking into consideration a greater number of characteristics than those employed by Gottsche (cf. Bartlett, 1928).

Stephani (1916) established the genus *Aspiromitus*, giving as the only tangible generic characteristic the possession of long elaters as opposed to "elateres nullis" (!) for *Anthoceros*. It is possible, that he had in mind the section B of Gottsche. The species listed by him under *Aspiromitus* appear,

[1] Being a continuation of papers published in the Annals of Botany as 'Studies on the morphology of Anthoceros.'

however, a somewhat heterogeneous assemblage, and the establishment of this genus created considerable confusion (Verdoorn, 1931). Thus, for instance, I find myself unable to imagine what generic characteristics Pearson (1923) had in mind, when he named his *Aspiromitus novazealandica*. (I have examined the type material of this species. It is a typical member of the yellow-spored section of *Anthoceros*.) It has been pointed out before (cf. e.g., Verdoorn, 1934), that Stephani's work at that time was no longer reliable. Goebel (1928), and later Rink (1935), attempted to emend *Aspiromitus* in the direction of the section B of Gottsche. Unfortunately both these authors considered exotic forms at this point, without a necessary reexamination of the original European species of *Anthoceros*, such as *A. punctatus* L., and of the first species of *Aspiromitus*, *A. husnoti* Steph. I have previously stated (Proskauer, 1948a) why I consider the genus *Aspiromitus* as untenable.

Frye and Clark (1947) also tried to emend *Aspiromitus*. Unfortunately, through an apparent lack of knowledge of the plants involved, they confused it with *Megaceros*, attributing to the former generic characteristics of the latter. No species of either genus are considered by them in their work; both genera, however, figure on their Phylogenetic diagram of Anthocerotales. They state: "We have separated the genus *Aspiromitus* Steph. from the genus *Anthoceros* on the basis of the absence of stomata in the former instead of the presence of spiral elaters."[2] Nobody had previously suggested that *Aspiromitus* possessed spiral elaters or lacked stomata, the two accepted points distinguishing *Megaceros* from yellow-spored *Anthoceros*.

Although the argument of this paper will be to show that the species left now under *Anthoceros* warrant placement under two generic headings, I shall, for clarity and convenience, use already in its development the name *Anthoceros* and the new name *Phaeoceros* in the way in which these genera will be defined in the concluding part.

The nature of the characteristics used in the classification of Anthocerotales. The commonest tangible features distinguishing species within the genera *Anthoceros* and *Phaeoceros* are:—sex-distribution, chromosome morphology, relative proportions and absolute dimensions of parts of both gametophyte and sporophyte, the sculpturing of the spore coat, and the behavior of the mature capsule (Proskauer, 1948b). In *Phaeoceros* chloroplast structure and storage tuber development are also of considerable importance. A consideration of these variables lies beyond the present terms of reference.

The accepted characteristics used in family and generic analysis of *Anthocerotales* are:—early eruption of sporophyte and constant presence

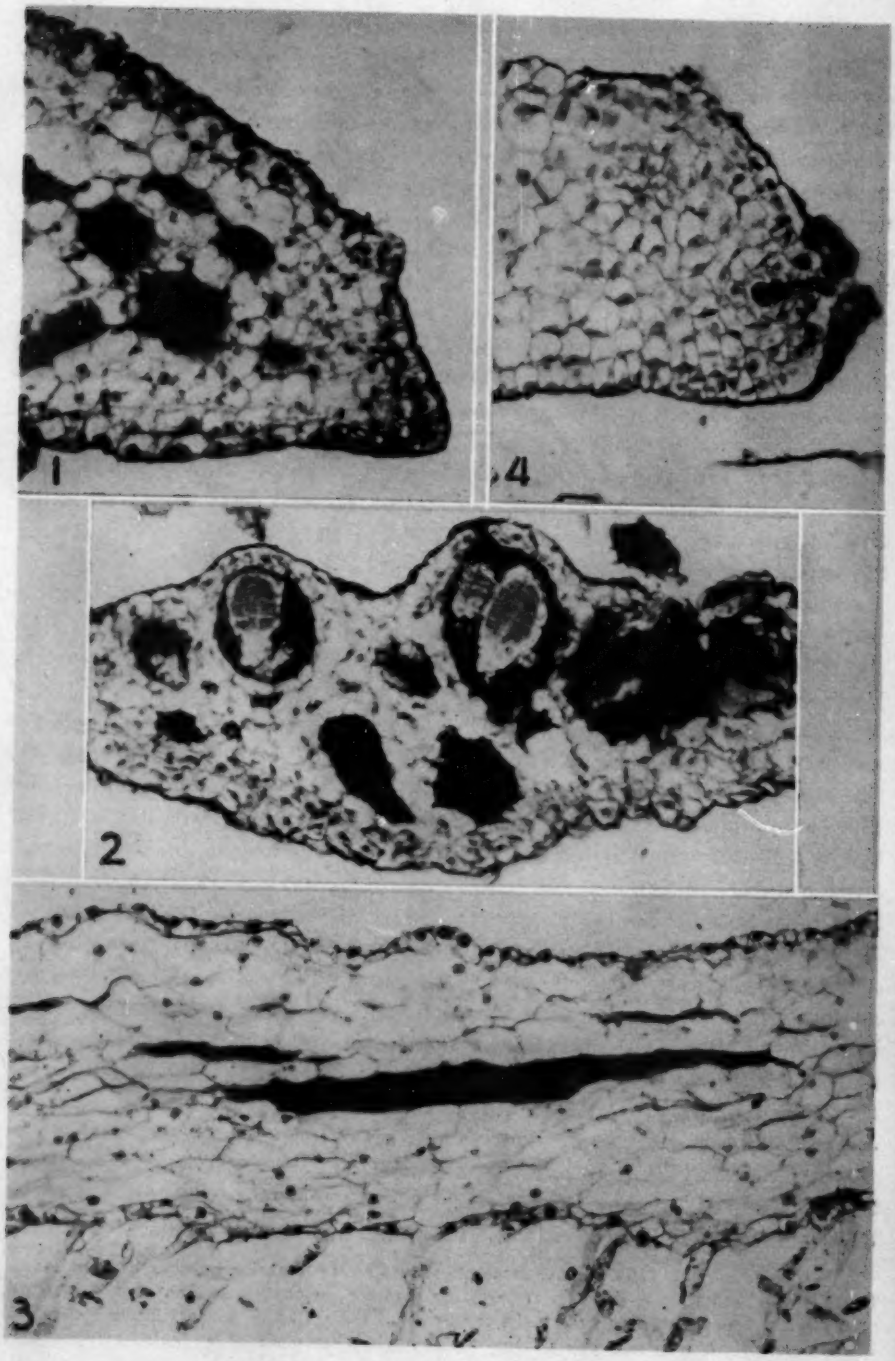
[2] This regrettable error has already reappeared in a key of genera of liverworts of New Zealand (Hodgson, 1950).

of columella (*Anthocerotaceae* versus *Notothylaceae* Müller [1940]); absence of elaters with regular spiral thickening (*Anthoceros* and *Phaeoceros* versus *Megaceros* and *Dendroceros*). It has generally been assumed that the presence of stomata in the sporophyte (considered by me as genetically homologous with the slime-pores present, as far as is known, in the gametophytes of all members of the order) constituted another feature distinguishing *Anthoceros* and *Phaeoceros* from *Megaceros* and *Dendroceros*. But there are exceptions to this. Goebel (1930) reported rudimentary stomata in *Megaceros* sp., and I failed to find stomata in the sporophyte of an African *Anthoceros* sp.

Points of difference between Anthoceros and Phaeoceros. It is usually possible to distinguish at a glance a member of the genus *Anthoceros* from a species of *Phaeoceros*. But such an identification is based on relative intangibles:—a tendency in many species of *Anthoceros* to the development of frilly lobes and frequently surface outgrowths of the thallus, and their somewhat lighter color, the latter feature presumably resulting from the spongy construction. The reliable generic characteristics are, however, all at the microscopic level.

Thallus. Both genera develop in conjunction with the stomata, or thallus-pores, chambers potentially harboring an algal endophyte, as first described by v. Janczewski (1872). In addition to these there are developed, in *Anthoceros*, schizogenous cavities behind the growing-point (figs. 1 and 2). In the older parts of the thallus these cavities usually have the appearance of tubes running parallel to the longitudinal axis of the lobe (fig. 3). These cavities may ultimately have a certain amount of interconnection. They are commonly filled with mucilaginous material, presumably secreted by the cells surrounding them. Therefore they have become known as mucilage or slime cavities. But they are not invariably thus filled. Occasionally they have gaseous contents, especially in the older parts of the thallus. This is easily demonstrated by submersing a thallus under water and observing it under low magnification. This observation has been confirmed for a number of species grown in culture, and for *A. fusiformis* also as gathered in the field. (Pandé and Bhardwaj, 1949). A number of authors have speculated that these cavities, taken together with the thallus pores, might represent a modification of an ancestral ventilating system. Should this be correct, it might be possible that some extant species, perhaps close to *A. erectus* Kash., would give us a closer indication of it. In *Phaeoceros* (fig. 4) there are merely occasional small intercellular spaces between the angles of the internal cells of the thallus.[3] These lack mucilage. Organs of perenna-

[3] Frye and Clark (1947) raise some question about "interior hollows." They give a figure, copied from Howe (1898), of a section through the thallus of *Phaeoceros pearsoni*, showing an alleged interior hollow. In the original the structure is not thus labelled and is presumably an ordinary cell of the thallus. Their account of *P. hallii* implies that


1
4
2
3

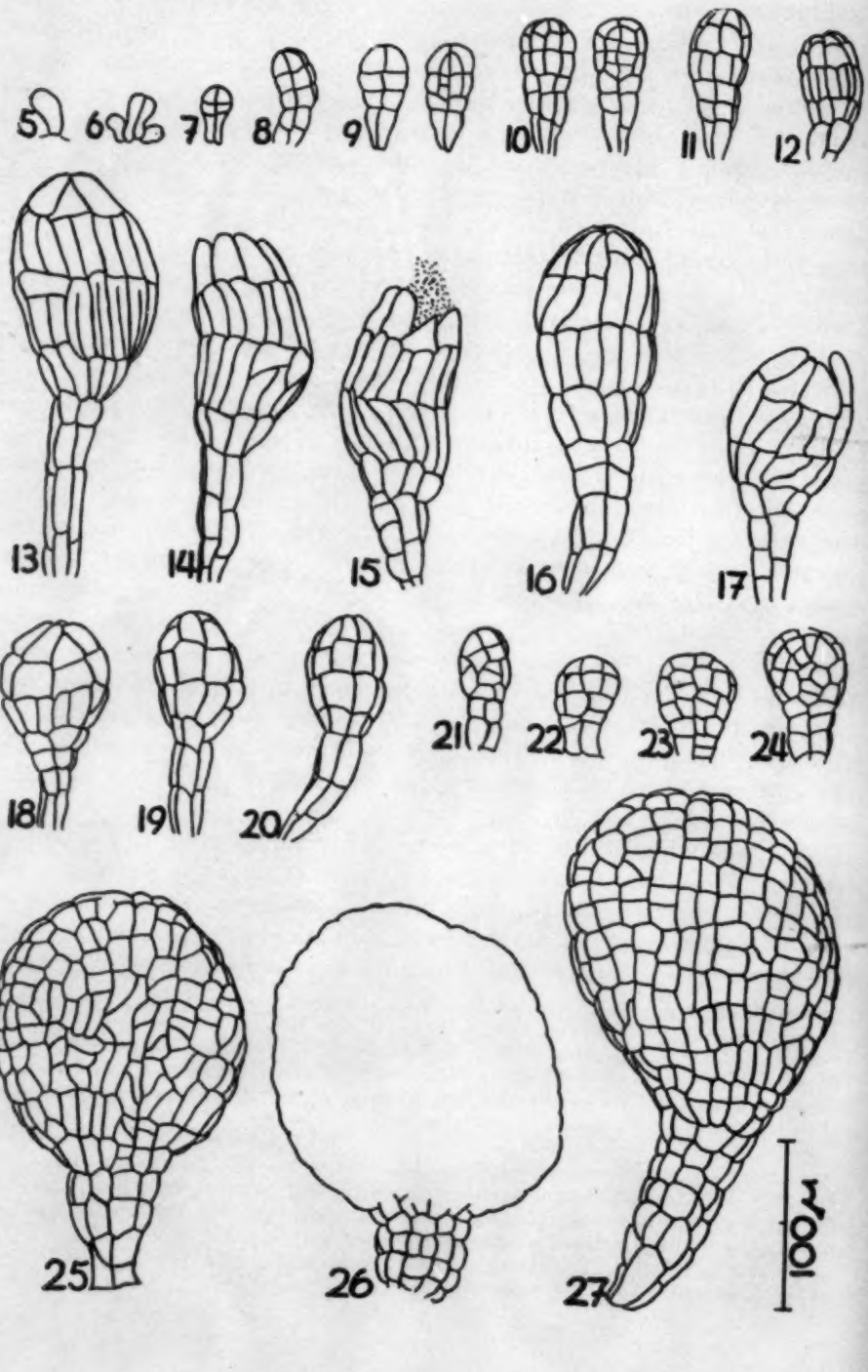
tion in the form of storage tubers borne in various ways have been recorded for several species of *Phaeoceros* (Ashworth, 1896; Howe, 1898; Goebel, 1930; Proskauer, 1948a, and numerous unpublished observations). Indeed, a survey of the literature suggests that they have been found in all species that have been closely examined. It is quite possible that the capacity to produce them is inherent in all the species of the genus. No such tubers have been described, to my knowledge, for species of *Anthoceros*, with the exception of *A. fusiformis* (Howe, 1898; Campbell, 1918).

Antheridium. In *Anthoceros*, as originally pointed out by Campbell (1918) for *A. fusiformis* (Goebel, 1928, 1930; Rink, 1935; Proskauer, 1948a; Pandé and Bhardwaj, 1949), the jacket of the mature antheridium is basically composed of four tiers of cells. These four tiers are established early in ontogeny (figs. 5–12). Within them division is generally restricted to the vertical plane, so that each tier appears composed of a palisade of cells. Figures 13–20 show this for a number of species. Occasionally one may find, especially if one searches for them, specimens with a limited amount of horizontal division (figs. 13 and 14, and also Bhardwaj's [1950] figure, taken from a plant called by him "*A. crispulus*"). But the general pattern of four tiers remains distinct. The cells of the top tier separate apically at the time of dehiscence (fig. 15). At an early stage antheridia of *Phaeoceros* may resemble those of *Anthoceros* (fig. 22). But further divisions in the jacket show much less regularity and are more abundant (figs. 21–24). Thus the mature antheridium, notwithstanding its absolute dimensions, has a jacket composed of relatively more, smaller, and less regularly arranged cells. The stalk, also, tends to be more massive (figs. 25–27), compared with the slender stalk of four rows of cells found in *Anthoceros* (figs. 13–20).

The antheridial initial of a young cavity rarely gives rise to only a single antheridium. Generally there is some (secondary) multiplication. In *Phaeoceros* this usually results in an indefinite but small number of antheridia per cavity, in *Anthoceros* an indefinite but large number (up to 25 or more) may be produced. This process is protracted in *Anthoceros*,

interior hollows have been reported here. After prolonged search I traced this back to Austin's (1875) description of the synonymous (*vide* Howe) *A. sulcatus*. But Austin's remarks appear in connection with the endophyte. At that time v. Janczewski's (1872) paper probably was not familiar to him, and he did not realize the true nature of these structures. I have examined living material of both *P. pearsoni* and *P. hallii*. Both lack cavities, as opposed to small intercellular spaces.

FIGS. 1–4. Photomicrographs of vertical sections through the thallus. *Anthoceros husnoti:* FIG. 1. Longitudinal section through growing-point region. FIG. 2. Section through region with several antheridial cavities, which also are filled with mucilage. FIG. 3. Longitudinal section through older part of a (thin) thallus. *Phaeoceros laevis:* FIG. 4. Longitudinal section through growing-point region of a female plant. FIG. 3. ×105, others ×210. Mucilage, stained by safranin, appears black.


5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
100 µm

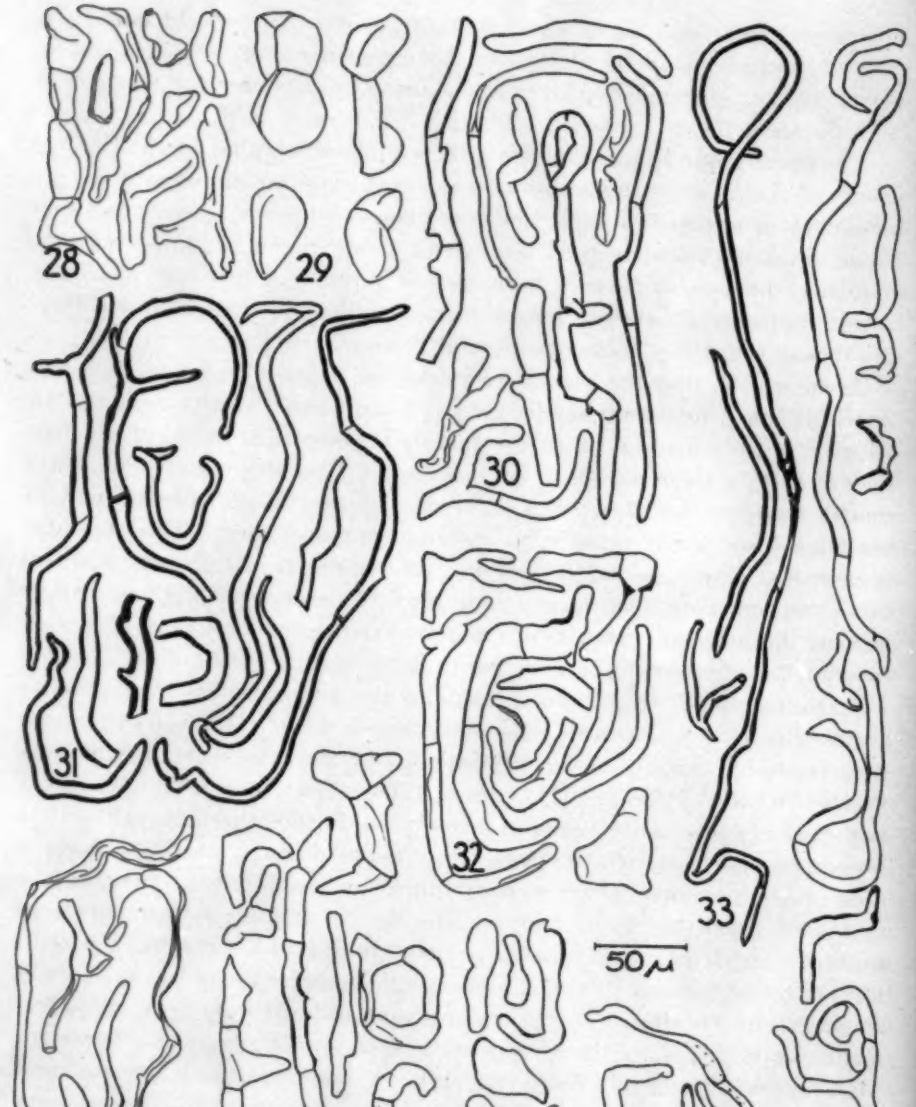
with a proliferation of new antaheridia from the bases of old ones. The resulting complex may be likened to the mixed sorus of certain ferns. It does, however, appear difficult to draw a sharp line between the two genera in this respect.

The sporophyte foot. Bartlett (1928) pointed out that the foot in the species of *Anthoceros* studied by her underwent regular divisions in its development, as opposed to an irregular sequence in those belonging to *Phaeoceros*. Examination of suitable sections of many species has indicated that there may be some difference, although of limited importance. Thus the largest species of *Phaeoceros* known to me (unidentified; from Corral Bay, Chile) may sometimes show considerable regularity in its foot. All that can safely be said is that the placenta, the deeply staining region of intimate contact between foot and gametophyte, is usually more clearly delimited in *Anthoceros* than in its ally. In the former the superficial cells of the foot tend to form a palisade layer. In *Phaeoceros* (Blaikley, 1933) there is a greater tendency for these cells to become haustorial or rhizoidal and to penetrate more deeply between the cells of the gametophyte. This rhizoidal development may occasionally be almost as marked as in species of *Megaceros*. Variation, both specific and individual, is considerable. These rather negative findings are not documented in this paper, as several pages of photomicrographs would be required to do so adequately.

Pseudoelaters. In all Anthocerotales the archesporium gives rise to sterile cells as well as spores. These sterile cells show a considerable range of variation in their ultimate development. But they are clearly homologous (Goebel and Suessenguth, 1927; Goebel, 1928,). They form tiers alternating with tiers of spore mother cells in *Notothylas;* in the other genera they are interspersed with the fertile cells, grow between them, and may form a more or less complete girder system linked by secondary contacts, in the meshes of which the spore mother cells lie. At this stage their function appears a nutritive one. At maturity they are dead cells, playing a part in dehiscence and spore dispersal depending in importance on their final structure. In *Notothylas* they then separate as individual cells. This frequently is the case too in certain species of *Anthoceros* and *Phaeoceros* (*A. ravenelii*, fig. 29; *P. hallii*, fig. 36). In *Dendroceros*, *Megaceros*, and most species of *Anthoceros* and *Phaeoceros* they separate in rows of more or less elongate cells, which may or may not show branching. In how far these structures are produced by division of individual sterile cells, and in

---

FIGS. 5–27. Antheridia. FIGS. 5–15. *Anthoceros husnoti* (Britain). FIGS. 5–12. Developmental stages. FIGS. 13–15. Mature. FIG. 16. *A. fusiformis* (California). Mature. FIG. 17. *A.* sp. (Central Chile). Mature. FIGS. 18–20. *A. punctatus* (England). Mature. FIGS. 21–27. *Phaeoceros laevis* (Britain). FIGS. 21–24. Developmental stages. FIGS. 25–27. Mature.


28
29
30
31
32
33
50μ
34
35
36
37
38

how far by secondary adhesion between them, is not clear. In *Dendroceros* and *Megaceros* the sterile cells at maturity are indurated with (single) spiral thickening bands laid down on the inside of the wall. In *Notothylas* thickening bands are frequently apparent too. Both *Anthoceros* and *Phaeoceros* lack regular spiral thickening. It has often been reported that they show rudiments of it. I have been unable to convince myself of this. In most cases where at first sight there seemed to be thickening bands, these proved to be simulated by foldings of the dried up walls (figs. 28, 30, 34, 35). The sterile cells or rows of sterile cells have been referred to as elaters or pseudoelaters; it seems superfluous to discuss the relative merits of these two terms here.

How far can these pseudoelaters provide taxonomic characteristics in *Anthoceros* and *Phaeoceros?* Figures 28–38 have been prepared to illustrate their range of variation in individual representative species. In each case they were obtained from the mature regions of usually one, but not more than four, sporophytes selected at random. It was soon apparent that the variation was much greater than indicated by most authors, who have been content to figure often but one or two pseudoelaters for any species. But this variation is not surprizing if one bears in mind that the pseudoelaters in most instances are formed by a haphazard breakdown of a haphazardly constructed three-dimensional girder system. The commonest form appears to be the unbranched or slightly branched filament. If intact spore-masses are examined, it can be seen that such filaments, as is to be expected, run longitudinally between the spores. It can be said that the longer the individual sterile cells tend to be, the fewer cross-connections are formed. Where few girder cross-connections are present, branched pseudoelaters will be less common. It is perfectly easy to pick out a single pseudoelater from each set, and to arrange these in a series, forgetting about individual variation. This might be justified if it were possible to find a typical elater representing a commonest type found in a species. But I have found this quite impossible in most instances. There is a variation in the amount of wall thickening normally shown in different species, and to some extent also in the absolute length reached by individual cells. On that basis one could place figures 29 and 33 at opposite ends of a series. But a complete intergradation is achieved by arranging all the others in between. It would clearly be impossible to draw a line. To draw such a line might have been

FIGS. 28–38. Pseudoelaters. FIG. 28. *Anthoceros punctatus* (England). FIG. 29. *A. ravenelii* (Florida). FIG. 30. *A. fusiformis* (California). FIG. 31. *A. argillaceus* Java, isotype material). FIG. 32. *A. husnoti* (England). FIG. 33. *A.* sp. (*A. pinnatus?* Cameroons). FIG. 34. *A. vegetans* (Cocos Island, Pacific. Isotype material). FIG. 35. *Phaeoceros laevis* (Wales). FIG. 36. *P. hallii* (California). FIG. 37. *P. pearsoni* (California. Isotype material marked x, rest material from type locality). FIG. 38. *P.* sp. (Amazonas, Perú).

in Stephani's mind when he established *Aspiromitus*. (An examination of copies of his own drawings [in Herb. Univ. Calif.] throws doubt even on this.) Now figures 31 and 33 represent typical *Aspiromitus* in the sense of Goebel's interpretation. Figure 28 represents the type species of *Anthoceros* (which, by chance, happens to be rather small and delicate in all respects), and figure 32 the type species of *Aspiromitus*. Where would, say, *Anthoceros fusiformis* (fig. 30) belong on such a basis? Perhaps the most clearly marked forms are those shown for *A. ravenelii*[4] and *P. hallii* (figs. 29 and 36). But certainly it would be ridiculous to separate these species from the remainder just on the count of their pseudoelaters.

Figures 28–34 and figures 35–38 represent the range of variation in what, for other reasons, are considered species of *Anthoceros* and *Phaeoceros* respectively. In each case there is a total variation from single cells to filaments of much elongated cells. The only difference appears to be that in *Anthoceros* at one extreme there is found a relatively heavier induration of the cell walls than in *Phaeoceros*.

Spore colour. The colour of the spores of *Anthoceros* at maturity may be dark brown, or smoky, or black. The same is true of the pseudoelaters, epidermis, and frequently the lining-layer. In *Phaeoceros* the spores are a translucent yellow in color. Contrary to a previous erroneous statement (Proskauer, 1948b) this color is not normally shared by the pseudoelaters. They, as well as the lining-layer and epidermis, assume a brownish coloration. Nothing is known about the chemical changes involved.

Dehiscence. It was previsously pointed out (Proskauer, 1948b) that the statement made by Bartlett (1928), that the valves in black-spored species do not twist at dehiscence, is incorrect. In both genera the usual method of dehiscence is by means of two splits which do not reach the apex of the capsule, coupled with a twisting of the valves. In both genera dehiscence may occasionally be by one split only, and certain species may sometimes even be indehiscent. It may be added that dehiscence by more than two splits, as indicated as possible by earlier work (Proskauer, 1948b), has now been observed. Three splits were seen in a capsule of an unidentified Chilean species of *Phaeoceros* growing in the field, the three valves adhering apically, and four valves were present in an old damaged capsule of a Peruvian member of the same genus in culture.

Discussion. Above it has been shown that the species comprising the current genus *Anthoceros* fall into two distinct groups, differing consistently in a series of points. Of these the difference in the construction of the thallus can be considered the major one. How far a similar difference recurs in other genera, especially *Dendroceros* and *Notothylas*, is still un-

[4] I have only seen herbarium material of this species. It appears interesting in several of its features and might well repay proper study from living material.

certain. I believe that an intensive study of the heterogeneous assemblage listed by Stephani under *Dendroceros* [*vide inter alia* copies of his own drawings] may ultimately supply the key to a proper understanding of the order.)

I am inclined to assign secondary significance to the other variant characters. The antheridial and color differences are very striking, perhaps especially because they appear so utterly incidental. But for this reason in particular they have to be considered with caution. (I have noted phaeoceroid antheridia in *Megaceros,* both types in *Dendroceros,* and in *Notothylas* phaeoceroid tending to anthoceroid. *Megaceros* has phaeoceroid coloring, in *Dendroceros* and *Notothylas* both kinds occur.)

Tuber formation seems best neglected for the moment, as does the structure of the foot. The latter would require a very lengthy study in comparative embryology, which, judging from observations made so far, is unlikely to prove worth the effort in the end. Pseudoelaters and dehiscence do not yield diagnostic characters. (Similarly they fail to do so within the *Dendroceros—Megaceros* pair.)

The differences listed here have been confirmed for an extensive range of distinct species. The accompanying table lists some of these. In it preferably those species have been listed in which observations have been based on type material, or in which identification has been reasonably certain. Many species so far only identified by a collection number, and others in which identification has been open to doubt[5], have been excluded.

The only anomalous specimen which I encountered was material of an *Anthoceros* from Africa labelled as *Anthoceros pinnatus* St. (1887, type from St. Thomé), collected by P. Dusén "prope Jonje pagum . . . Camerunia", 22. xi. 1891 (in Herb. Univ. Wisconsin). This material lacks stomata in the sporophyte; occasional irregular clusters of cells are present. The stomata in the gametophyte are normally developed. Stephani (1916) lists several species which appear anomalous. It has been possible to check on a number of these. In each case Stephani's description was incorrect. *Aspiromitus argillaceus* St. is listed as black-spored, lacking cavities. The isotype has cavities. *Aspiromitus tonkinensis* St. "pale spores, cavities" lacks cavities (*vide* copy of Stephani's own drawing) and will probably go into *Phaeoceros,* after an inspection of the type material. *Anthoceros pearsoni* Howe is listed by Stephani as having cavities. It lacks them (Howe, 1898; and isotype). The same applies to *A. donellii* Austin (1879; and Howe, 1898). Besides the work of Stephani, which can safely be dis-

[5] I have, for instance, come across herbarium specimens of what appear to be the same Brazilian species under three different identifications by different authorities. This probably merely means that there is a synonym complex involved, but none of the respective types was available to me.

Species of *Anthoceros*	Thallus with cavities	Thallus solid	Monoecious	Dioecious*	'4-tiered' antheridia	'Irregular' antheridia	Spiral elaters absent	Spores brown to black	Spores yellow	Locality	Basis for statements	Remarks
A. argillaceus	x			?	x		x	x		Java	Isotype. Verdoorn, Hep. sel. et crit. IV. 178.	
A. dixitianus	x			x	x		x	x		near Bombay	Mahabalé, 1941.	
A. fusiformis	x		x		x		x	x		California	Living material.	
A. husnoti	x		x		x		x	x		Britain	Living mat., Proskauer, 1948a.	
A. indonesicus	x		x		x		x	x		Sumatra	Goebel, 1928.	as *Aspiromitus gracilis*
A. kajumas	x			?	x		x	x		Java	Goebel, 1928.	
A. khandalensis	x			x	x		x	x		near Bombay	Apte and Sane, 1942.	
A. punctatus	x		x		x		x	x		England	Living mat., Proskauer, 1948a.	
A. ravenelii	x		x		x		x	x		Florida	Mat. *leg.* Rapp (Herb. Univ. Calif.); Howe, 1898.	Verdoorn, Hep. sel. et crit. 200 (Herb. Univ. Calif.) does not belong here.
A. sampalocensis	x			x	x		x	x		Luzon	Rink, 1935.	
A. sp.	x		x		x		x	x		Central Chile	Living mat., Proskauer, locs. C8, 14.	
A. sp.	x			?	x		x	x		Cameroons	Mat. *leg.* Dusén (Herb. Univ. Wisconsin)	as *A. pinnatus* No stomata in capsule.
A. vegetans	x		x		x		x	x		Cocos Isl., Pacific	Type and isotype mat., Herb. Calif. Acad. Sc.)	

Herb. Calif. Acad. Sc.)

Species of *Phaeoceros.*	Thallus with cavities	Thallus solid	Monoecious	Dioecious*	'4-tiered' antheridia	'Irregular' antheridia	Spiral elaters absent	Spores brown to black	Spores yellow	Locality	Basis for statements	Remarks
P. carolinianus		x	x			x	x		x	South Carolina, California	Living material.	
P. dichotomus		x		?		x	x		x	Mediterranean	Mat. leg. Nicholson, (Herb. Brit. Mus.); Howe, 1898 p. 13.	
P. dixiti		x		x		x	x		x	near Bombay	Sane, 1942.	
P. hallii		x		x		x	x		x	California	Living material; Howe, 1898.	incl. *A. phymatodes.*
P. laevis		x		x		x	x		x	Britain	Living mat.; Type (Linn. Herb.), Proskauer, 1948a.	
P. novazealandicus		x		x		x	x		x	New Zealand	Type mat. (Herb. Univ. Calif.)	
P. pearsoni		x		x		x	x		x	California	Living mat. from type loc.; Isotype (Herb. Brit. Mus.)	
P. sp.		x	x			x	x		x	Amazonas, Perú	Living mat., Proskauer, loc. P2.	
P. tjipanasanus		x	x			x	x		x	Java	Rink, 1935.	

* Based on observation; cytological and genetical proof only in two instances (Rink, 1935; Proskauer, 1948a)

regarded in this respect, a search of the literature has provided but three other 'anomalous' descriptions. In Howe's (1934) meticulous description of his *Anthoceros vegetans,* from the Pacific Ocean Cocos Island, he states that it has cavities and pale yellow spores, and that it belongs to the *A. laevis* group. He also remarked that the capsules, in his material, were not fully mature. Mr. J. T. Howell, of the California Academy of Sciences, kindly made available to me his collection Nr. 234, the type material. Apparently Howe saw only part of this, with only unripe capsules. A ripe capsule was found in the isotype. The spores and pseudoelaters are dark brown. The pseudoelaters (fig. 34) and columella are quite normal. Khanna's (1933) briefly described *Anthoceros parkinsonii* is listed as having yellow-brown spores and lacking cavities in the involucre (but thallus?). His *Anthoceros koshii* (1936) might possibly be a *Phaeoceros* with dark spores. Both species need reinvestigation.

The evidence is interpreted as warranting the establishment of the genus *Phaeoceros* (type *P. laevis*), to comprise the forms with solid thallus, leaving those with cavities in the thallus with *Anthoceros* (type *A. punctatus*). The type and most species listed under *Aspiromitus* St. belong to *Anthoceros* (Proskauer, 1948a). This interpretation is in keeping with the conclusions reached by Bartlett (1928). It would probably also have been arrived at by Goebel and Rink, had these authors complemented their investigations of exotic forms with a careful reexamination of their local European original species of *Anthoceros,* which formed the starting point of the present studies.

It might well be, although beyond proof, that *Anthoceros* and *Phaeoceros* individually are more closely related to *Dendroceros* and *Megaceros* than they are to each other.

Future work on the genera. It is hoped that the present paper will contribute to the clearing of the ground prerequisite to further morphological and other work on the group, a clearing necessitated by the disastrous effects of Stephani's treatment. The *genus confusum Aspiromitus* St. should disappear from the scene at last. It received its *reductio ad absurdum* in the paper by Apte and Sane (1942), who allotted two species to it on the basis of their four-tiered antheridia alone. One species has long thick-walled pseudoelaters, the other ordinary short-celled ones. Why Sane (1942) failed to place his *Anthoceros sahyadrensis* in *Aspiromitus* is a mystery; on the basis of their concept it has as much right to being there as the species created by Apte and Sane at the same time.

The majority of species have, as a conservative estimate, at least four synonyms, frequently as a result of the tendency to describe as new plants from a new region. The only way to ascertain this definitely is by examination of type material and by growing side by side plants from different

areas. As regards the latter point, it has so far been possible to find counterparts to the living material of *Anthoceros* and *Phaeoceros* sent to me from New Zealand in plants collected in Chile, and for other plants from Chile in plants from California. The species with the greatest number of synonyms appear to be *Phaeoceros laevis* (Proskauer, 1948a) and *P. carolinianus* (differing from it by being monoecious and having a different chromosome morphology; to be described), two common northern hemisphere forms, described as new again and again. Sometimes it is possible to pick out probable synonym chains at first sight. Thus, judging from the original descriptions, *Anthoceros fergussoni* (Apte and Sane, 1942) appears to be a synonym of *Anthoceros dixitianus* (Mahabalé, 1941) from the same area in India. The objections raised against this by Apte and Sane are not serious. They are partially based on characters which are not reliable taxonomically. The thalli of the two plants are basically identical, according to the diagrams if not the text. The only serious objection lies in the dimensions of the antheridial body, listed by Mahabalé as 34 μ long, which sounds improbably small. But in his figures (with magnification stated) one finds that he pictured the antheridial bodies as being about 540 μ and 950 μ long in different illustrations, clearly much too large. This suggests the advisability of remeasurement on the type specimen, should such exist. In turn *A. dixitianus* appears a synonym of *Anthoceros weistii* Khanna (1932) from Burma (isotype seen), which, in turn, appears identical with *Anthoceros argillaceus* St. ex Verdoorn from Java (isotype seen). This, in turn, has very likely older synonyms. It would be useful if some worker in India might check on parts of the suggested chain, using types and living material.

The truly vast amount of probably mainly "bad" species described by Stephani are known generally just from his scanty diagnoses, which are not reliable. Only very rarely do they afford safe identification, as was found the case with *Phaeoceros propaguliferus* (St.), with its very striking marginal tubers, which I unsuspectingly collected in its type locality in Chile. For all practical purposes most of his names are hardly more than *nomina nuda*, a reference to their type material is necessary to circumscribe them, and to determine their status. Pandé and Bhardwaj (1949) adopted an original although illegal, according to international rules, method of approach to the problem. They gave an excellent description of a species from India, and then called it *Aspiromitus harrisanus* St., according to that scanty diagnosis in Stephani's works which most fitted it (although not too well as to the spores). Stephani's plant came from Jamaica; it may have been the same species or it may not. They failed to refer to the type specimen, presumably in Genève. But they deposited a type for Stephani's Jamaican species from their Indian material!

Further comparative work, especially on chloroplast morphology, might lead to the recognition of subgroupings in *Phaeoceros* as foreshadowed by Bartlett (1928).

Taxonomic changes. The following is a compilation of changes proposed in all the papers of this series to date. I am avoiding a wholesale recombination of names; where necessary this should be done in conjunction with study of authentic material, as different species come up for revision.

Anthoceros [Micheli] L. (1753), emend. nov.[6]

Incl. *Aspiromitus* Stephani (1916) *pro parte maiori* (Proskauer, 1948a).
Proprietates primariae: Thalli cum cavis magnis a cellularum separatione procreatis. Sporogonium cum perpetua regione intercalari cellularum divisione. Columella quae adest. Pseudoelateres sine spirae regulari induratione.
Proprietates secundariae: Antheridia quorum corporum membrana quattuor cellularum ordinibus formata est. Sporogonii epidermis stomatifera—una exceptione cognita. Sporarum color fulvus vel fuscus vel fumosus vel niger est.
Species lectotypica: *Anthoceros punctatus* L. (Proskauer, 1948a)
Characteristics of primary importance: Gametophyte with large schizogenous cavities. Sporophyte with persistent intercalary meristem. Columella present. Pseudoelaters without regular spiral thickening.
Characteristics of secondary importance: Jacket of body of antheridium composed of four tiers of cells. Epidermis of sporophyte with stomata (one exception known). Color of spores dark brown, smoky, or black.
Lectotype species: *Anthoceros punctatus* L. (Proskauer, 1948a)

Phaeoceros gen. nov.

Proprietates primariae: Thalli sine cavis magnis a cellularum separatione procreatis. Sporogonium cum perpetua regione intercalari cellularum divisione. Columella quae adest. Pseudoelateres sine spirae regulari induratione.
Proprietates secundariae: Antheridia quorum corporum membrana multis parvis cellulis composita, quae quattuor cellularum ordines conspicuos non formant. Sporogonii epidermis stomatifera. Sporarum color flavens translucens.
Species typica: *Phaeoceros* (*Anthoceros*) *laevis* (L.)
Phaeoceros propter maturi sporogonii usitatum colorem.[7]
Characteristics of primary importance: Gametophyte without large schizogenous cavities. Sporophyte with persistent intercalary meristem. Columella present. Pseudoelaters without regular spiral thickening.

---

[6] The name *Anthoceros*, "flower-horn," clearly is not in keeping with current botanical interpretation. Necker (1790), already for this reason, proposed to replace it by *Corypta* (no specific combinations extant to my knowledge), and Dumortier (1922) proposed *Carpoceros*. The latter might have been taken up now instead of *Phaeoceros*, but unfortunately it is a later variant homonym of *Carpoceras* DC. of 1821 (= *Thlaspi* Tourn.), also written *Carpoceros* by Reichenbach (*fide* L. Pfeiffer, Nomenclator botanicus). Both *Corypta* Neck. and *Carpoceros* Dum. have to be rejected *prima facie*.

[7] I am indebted to Dr. Pia Schizzano for preparing the Latin diagnoses.

Characteristics of secondary importance: Jacket of body of antheridium composed of many small cells, not clearly arranged in four tiers. Epidermis of sporophyte with stomata. Color of spores translucent yellow.
Type species: *Phaeoceros* (*Anthoceros*) *laevis* (L.)
Phaeoceros because of the usual color of the mature sporogonium.
Anthoceros dixitianus (Mahabalé) comb. nov.; syn. *Aspiromitus dixitianus* Mahabalé (1941).
Anthoceros fergussoni (Apte et Sane) comb. nov.; syn. *Aspiromitus fergussoni* Apte et Sane (1942); probably a synonym of the preceding species. *Anthoceros husnoti* St.; syns. *Anthoceros stableri* St., *Anthoceros longicapsulus* St., *Aspiromitus husnoti* St., lectotype of *Aspiromitus* St. (Proskauer, 1948a).
Anthoceros indonesicus nom. nov.; syn. *Aspiromitus gracilis* Goebel (1928), non *Anthoceros gracilis* Reichardt (1866) = *Megaceros gracilis* (Reichardt) St. (1916).
Anthoceros kajumas (Goebel) comb. nov.; syn. *Aspiromitus kajumas* Goebel (1928).
Anthoceros khandalensis (Apte et Sane) comb. nov.; syn. *Aspiromitus khandalensis* Apte et Sane (1942).
Anthoceros punctatus L.; lectotype of *Anthoceros* L.; syn. *Anthoceros crispulus* (Mont.) Douin (Proskauer, 1948a).
Anthoceros sampalocensis (Burgeff in Rink) Prosk. (1948a); syn. *Aspiromitus sampalocensis* Burgeff in Rink (1935).
Anthoceros vegetans Howe (1934); diagnosis emend.:—sporis fuscis; pseudoelateres conspicuis; columella glabra. Spores dark brown; pseudoelaters conspicuous; columella smooth.
Phaeoceros carolinianus (Michx.) comb. nov.; syn. *Anthoceros carolinianus* Michx. (1803; Howe, 1898).
Phaeoceros dichotomus (Raddi) comb. nov.; syn. *Anthoceros dichotomus* Raddi (1808; Howe, 1898) p. 13.
Phaeoceros dixiti (Sane) comb. nov.; syn. *Anthoceros dixiti* Sane (1942).
Phaeoceros hallii (Austin) comb. nov.; syns. *Anthoceros hallii* Austin (1875), *Anthoceros phymatodes* Howe (1898). (On evidence of cultures; Frye & Frye Nr. 2993 [Frye and Clark, 1947], kindly lent by Prof. Frye, does not belong here.)
Phaeoceros laevis (L.) comb. nov.; type of genus *Phaeoceros;* syns. *Anthoceros laevis* L. (1753), *Anthoceros incrassatus* Schiffner (Proskauer, 1948a); additional syns. *Anthoceros beltrani* Casares-Gil (1915; material kindly supplied from Museo Nacional de Sciencias Naturales, Madrid), *Anthoceros curnowii* St. (1916).
Phaeoceros novazealandicus (Pears.) comb. nov.; syn. *Aspiromitus novazealandica* Pearson (1923) (type seen).
Phaeoceros pearsoni (Howe) comb. nov.; syn. *Anthoceros pearsoni* Howe (1898).
Phaeoceros propaguliferus (St.) comb. nov.; syn. *Anthoceros propaguliferus* St. (1916; material from type locality seen).
Phaeoceros tjipanasanus (Burgeff in Rink) comb. nov.; syn. *Anthoceros tjipanasanus* Burgeff in Rink (1935).
Anthoceros multifidus L. = *Jungermannia multifida* L. = *Riccardia multifida* (L.) S. F. Gray (Proskauer, 1948a, p. 260).

SUMMARY

1. Past and present studies on a considerable number of species of the *Anthoceros* complex suggested that they fall within two groups. The genus *Anthoceros* L., emend., comprises the forms with cavities in the thallus; a new genus, *Phaeoceros*, those without them. The variation within various characters, and their possible diagnostic value, are discussed in detail.

2. New diagnoses and taxonomic changes necessitated by this work are compiled in the concluding section.

DEPARTMENT OF BOTANY, UNIVERSITY OF CALIFORNIA,
BERKELEY, CALIFORNIA

Literature Cited

Apte, V. V., and Sane, P. V. 1942. Two new species of *Aspiromitus* St. from Bor Ghat (Lonavla and Khandala). Jour. Univ. Bombay N.S. **10** Pt. **5B**: 80–85.

Ashworth, J. H. 1896. On the structure and contents of the tubers of *Anthoceros tuberosus*, Taylor. Mem. and Proc. Manchester Lit. and Phil. Soc. **41** Mem. 2.

Austin, C. F. 1875. Notes on the Anthocerotaceae of North America, with descriptions of several new species. Bull. Torrey Club **6**: 25–29.

———. 1879. Notes on hepatology. Bull. Torrey Club **6**: 301–306.

Bartlett, E. M. 1928. A comparative study of the sporophyte in the Anthocerotaceae, with special reference to the genus *Anthoceros*. Ann. Bot. **42**: 409–430.

Bhardwaj, D. C. 1950. Studies in Indian Anthocerotaceae. I. Jour. Indian Bot. Soc. **29**: 145–163.

Blaikley, N. M. 1933. The structure of the foot in certain mosses and in *Anthoceros laevis*. Trans. Roy. Soc. Edinb. **57**: 699–709.

Campbell, D. H. 1907. Studies on some Javanese Anthocerotaceae. I. Ann. Bot. **21**: 471–486.

———. 1918. Mosses and ferns. 3rd ed. New York.

Casares-Gil, A. 1915. Muscíneas de la Península Ibérica. Trab. Mus. Nac. Cienc. Nat. Madrid Ser. Bot. **8**.

Dumortier, B. C. 1822. Commentationes botanicae. Casterman-Dieu, Tourney.

Frye, T. C., and Clark, L. 1947. Hepaticae of North America. V. Univ. Wash. Publ. Biol. **6**: 735–1022.

Goebel, K. E. 1928. Morphologische und biologische Studien. XII. Malesische Lebermoose. Ann. Jard. Bot. Buitenzorg **39**: 1–116.

———. 1930. Organographie der Pflanzen. II. Bryophyten- Pteridophyten. 3. Aufl. Fischer, Jena.

———, **und Suessenguth, K.** 1927. Archegoniatenstudien. XVII. Die Sporelaterteilung bei den Lebermoosen. Flora N.F. **12**: 33–56.

Gottsche, C. M. 1858. Übersicht und kritische Würdigung der . . . . . Leistungen in der Hepatologie. Beil. Bot. Zeit. 1–49.

———, **Lindenberg, J. B. G., Nees v. Esenbeck, C. G. D.** 1844–47. Synopsis hepaticarum. Meissner, Hamburg.

Hodgson, E. A. 1950. The classification of New Zealand hepaticae. Tuatara **3**: 20–32.

Howe, M. A. 1898. The Anthocerotaceae of North America. Bull. Torrey Club **25**: 1–24.

———. 1934. The hepaticae of the Galapagos Islands and the coast and islands of Central America and Mexico. (Templeton Crocker Exped., 17) Proc. Calif. Acad. Sc. 6. Ser. **21**: 199–210.

Janczewski, E. v. 1872. Zur parasitischen Lebensweise des *Nostoc lichenoides*. Bot. Zeit. 73–82.

Khanna, L. P. 1932. A new species of *Anthoceros* from Rangoon. Bot. Gaz. **93**: 103–104.

————. 1933. A new *Anthoceros* from Burma. Jour. Bot. **71**: 125–127.

————. 1936. On Indian species of the genus *Anthoceros* Linn., with a description of a new species from Travancore. Jour. Indian Bot. Soc. **15**: 235–240.

Linné, K. v. 1753. Species plantarum. II. Stockholm.

Mahabalé, T. S. 1941. On a long-lost liverwort from South India: *Aspiromitus*, a rare member of Anthocerotes. Current Science **10**: 530–533.

Michaux, A. 1803. Flora boreali-americana. II. Paris.

Müller, K. 1940. Die Lebermoose. Rabenhorst's Kryptogamen-Flora VI. (Ergänzungsband) 2. Lieferung. Leipzig.

Necker, N. J. de 1790. Elementa botanica. Neuwied.

Pandé, S. K., and Bhardwaj, D. C. 1949. Studies in Indian hepaticae. VI. Jour. Indian Bot. Soc. **28**: 15–27.

Pearson, W. H. 1923. More New Zealand hepaticae. Univ. Calif. Publ. Bot. **10**: 373–393.

Proskauer, J. 1948a. Studies on the morphology of *Anthoceros*. I. Ann. Bot. **12**: 237–265.

————. 1948b. Studies on the morphology of *Anthoceros*. II. Ann. Bot. **12**: 427–439.

Raddi, G. 1808. Atti Accad. Sc. Siena **10**: 289. (Not. seen.)

Reichardt, H. W. 1866. Diagnosen der neuen Arten von Lebermoosen, welche die Novara-Expedition mitbrachte. Verh. Zool.-Bot. Ges. Wien **16**: 957–960. (Also abstr.: Hedwigia 1869. **8**: 28–30.)

Rink, W. 1935. Zur Entwicklungsgeschichte, Physiologie und Genetik der Lebermoosgattungen *Anthoceros* und *Aspiromitus*. Flora N.F. **30**: 87–130.

Sane, P. V. 1942. Observations on some species of *Anthoceros* Linn. from Poona and the neighbouring hills of the western Ghats. Jour. Univ. Bombay N.S. **10**: Pt. **5B**: 86–96.

Stephani, F. 1887. Hepaticae africanae. Bot. Jahrb. (Engler) **8**: 79–95.

————. 1916. (1912–17) Species hepaticarum. V. Genève.

Verdoorn, F. 1941. De Levermoosgeslachten van Java en Sumatra. Ned. Kruidkundik Arch. 461–509.

————. 1932. Hepaticae selectae et criticae. Ser. III et IV. Ann. Bryol. **5**: 125–144.

————. 1934. Studien über asiatische Jubulae. Mit einer Einleitung: Bryologie und Hepatologie, ihre Methodik und Zukunft. Ann. Bryol. 6 (Suppl.)

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, NO. 4, pp. 350–352 JULY, 1951

TORREYA

A Note on the Blooming of Drummond's Primrose. A yellow evening-primrose, *Oenothera Drummondii* Hook.,[1] grows on the sand dunes of the barrier islands of the south Texas coast. Each plant is a low, supine bush. It is scattered and nowhere covers the ground. Several flowers bloom from the same plant, although at different times.

Although the annual range of temperature in this climate is from below freezing to 100° F., the plant blooms perennially and certain facts in this connection are worth recording.

True to its name this plant opens its large yellow blossoms at dusk. They remain open only one night and close and wither away next morning when the sun strikes. Blossoming is in greatest abundance in the summer and at the dawn of a summer day the dunes are sprinkled with yellow as far as the eye can see. On cloudy or foggy days the flowers bloom by day, staying open that day or the next until touched by bright sunlight.

In the fall and winter the number of blossoms diminish but a few may be seen every morning. In December, 1950 there was one cold spell during which the temperature fell to below freezing during the night. The next morning four primroses were in bloom in front of the Institute buildings. They remained several hours of the morning but faded away in the midmorning sun. A bobwhite came along and ate two petals off one blossom, but apparently did not greatly relish the fare and went on his way.

An even more striking case of cold weather blooming was observed during the memorable freeze of January 29–February 2, 1951. On the night of January 29 the temperature at Port Aransas fell to 24° F. Nevertheless, one primrose bloom was open at the Institute next morning. The following day was cloudy and the cold increased. The flower did not fade or close and like everything else outdoors slowly became encased with ice. This killed the bloom and the petals were frozen and limp when the thaw came. They dropped off and the usual closing process did not take place. Since the freeze, no more blooms have been seen and the *Oenothera* plants lie withered and dead, appareantly killed by the extreme cold.

From these observations we may conclude that *Oenothera Drummondii* blooms over an amazingly wide range of temperature (*circa* 75° F.) in the heat of summer and cold of the winter, and further that it continues to bloom at temperatures approaching the lower limits which the parent plant can survive.—GORDON GUNTER, Institute of Marine Science, The University of Texas, Port Aransas, Texas.

BOOK REVIEWS

Compendium van de Terminologie, Nomenclatuur en Systematiek der Zaadplanten. By A. A. Pulle. Second Edition. 370 pp. illustrated. N. V. A. Oosthoek's Uitg. Mij. Utrecht. 1950.

This volume on the seed plants is divided into three parts, as the title indicates. In the first, which deals with terminology, the types and characteristics of leaves, stems, roots, inflorescences, flowers, fruits, seeds, etc. are categorically defined for use in part 3 of the book. Seventy pages are devoted to this itemized presentation. The next eighty pages, constituting part two, are devoted to nomenclature; synonyms, homonyms, valid publication, rule of priority, the type method, and changes in the rules adopted by the Stockholm Congress of July 1950 are a few of the topics elaborated in this portion.

[1] I am indebted to Dr. Eula Whitehouse, of Southern Methodist University, for the correct name of this plant.

The third part, which is the largest—some two hundred pages—, and which for most readers will be the most nutritious, takes up the classes, orders and families of seed plants, starting with the cycads and ending with the Hippuridaceae. In the angiosperms the monocotyledons are considered first, beginning with the aroids and the palms and ending with the orchids. Treatment of the dicotyledons starts with *Casuarina* and the Amentiferae and finishes with the Hippuridales. The fifty-five orders of the dicotyledons are grouped into eight different series. There is a chart, in color, of the "Systeem der Angiospermae." Others may find it difficult, for instance, to derive the Ranales from the Amentiferae by way of the Hamamelidales; or the Plantaginales, Callitrichales and Hippuridales from the Tubiflorae; but at least the author has had the fortitude to depart, in some ways, from the time-honored but outdated concepts of interrelationships. Each family of the angiosperms is portrayed by a cogent description, almost all are illustrated by one, or in some cases two, floral diagrams,—habit drawings are not given—, and characteristic and important genera are listed. The author pays homage to Goethe with selected quotations.

This "Compendium" is neat, compact, and helpful. It embraces a mass of information which is concisely and tersely presented. Familiarity with Dutch will be an advantage, but knowing English, German and a little Latin, you may actually have more fun.—EDWIN B. MATZKE, Columbia University.

Conservation of Natural Resources. By Guy-Harold Smith, editor. XII + 552 pages; fig. 1–173. John Wiley and Sons, Inc. New York. 1950.

Under the above title appears a revision of the pioneer book on conservation "Our Natural Resources and Their Conservation" by Parkins, Whitaker, et al. The revised edition presents the ramifications of conservation in 23 chapters, grouped into 8 parts or units. The outline, approach, and presentation of subject matter are essentially the same as the book by Parkins and Whitaker. In recent years some of the chapters in the pioneer text had become sorely in need of being brought up to date. The writers of the new edition have fulfilled the obligation excellently. It is to be regretted, however, that the unscientific term "plant food" appears in chapter 8, when the plant physiologist's "mineral element" or "raw materials" is implied. On page 350 is the amazing estimate that a foot of peat accumulates in 100 years. Where would that place the events of post-Pleistocene happening? Radiocarbon studies date peat collected by the reviewer at the 8-foot level of a bog in Minnesota as 7,000 years, giving a range for the area (20 bogs) as 500 to 1,000 years per foot of peat. For the highly compacted peat of Indiana the age no doubt runs much higher than that of the Minnesota peat.

The content of "Conservation of Natural Resources" covers all the major fields of our resources as well as the history of the conservation movement in our country. Included are: Soil, grasslands, forests, water supply, water power, flood control, minerals, fuels, wildlife, fisheries, recreation, local and national planning, and a chapter on conservation of the human element of the nation. The book maintains an excellent balance between the various fields so that no subject appears to be overemphasized, especially not the recreational phase of parks, fishing for sport, hunting, or the minor aspects of conservation, which, however, in state and local conservation activities overshadow the real issue involved.

The chapters on minerals and oil are among the most gripping and alarming at the same time. This is no doubt in part due to the controlling part they play in our age of speed and mechanized life, and their apparently rapid decline in abundance. Involuntarily one wonders how man will adjust himself within less than a century to the limited reserves of these vital resources and to substitutes which at present appear distinctly inferior, especially as this refers to the present use of copper and iron. The authors express pessimism when viewing the future. None of them, however, seem to realize the fact that even the wisest use would not insure adequate supply of these resources for more than a century or perhaps two. We must face the fact that there are simply not

sufficient supplies for a multiplying humanity. The most destructive single factor in the overall picture is no doubt war, and preachers of conservation would certainly appeal to deaf ears when the leaders of nations prepare for bigger and more destructive conflicts. America, has, indeed, been very fortunate in that so many people of the world have not aspired to such high standards of living as we have, especially from an automotive angle, otherwise there would be no resources of iron, copper, and oil left in the world.

The book is outstanding for its frank statistical presentation of facts, and absence of vague generalities. The book is not too profusely illustrated, which the reviewer considers an asset and not a liability. Good tables and summarized data are much more thought-provoking and convincing than too many pictures on the same subject. An excellent feature is presentation of data on resources still available in comparison with the amount which has been exhausted. The book is a challenge to the people of the United States, and one regrets that it will, like most books of its kind, reach comparatively few of the people who use and who harvest the country's resources.—J. E. POTZGER, Butler University, Indianapolis, Indiana.

NOTE

Dr. M. Pierce Rucker has been writing floral eponyms and publishing them in the Virginia Medical Monthly for some time. It has been suggested that these should be more widely circulated among botanists. We have permission to reproduce them and plan to do so as space permits.

FLORAL EPONYM

Alpinia (Alpinus Prosper, 1553-1617) is a large genus of Zinziberaceous plants of Asia, Australia, and Polynesia. *A. galanga* and *A. officinarum* yield galargal, or China root.

Alpinus (Alpino or Alpini), an Italian physician and botanist, was born at Marostica, in the republic of Venice, studied medicine at Padua and practiced medicine, although he is perhaps better known as a botanist. For three years he lived in Egypt, where he was the physician to the Italian Consul in Cairo. Here he studied the palm tree and deduced the doctrine of the sexual differences of plants, which was adopted as the foundation of the Linnaean system. In 1593 he was appointed professor of botany at Padua.

He wrote an excellent historical account of the medicine of the Ancient Egyptians as well as various epidemiological studies. He is credited with introducing coffee and moxa from the Orient. Garrison says that his work on prognosis was not surpassed until the 20th Century.—M. PIERCE RUCKER, M.D., and Virginia Medical Monthly.

BULLETIN OF THE TORREY BOTANICAL CLUB

VOL. 78, No. 4, 353–362 JULY, 1951

INDEX TO AMERICAN BOTANICAL LITERATURE

COMPILED BY

LAZELLA SCHWARTEN

WITH THE COLLABORATION OF THE EDITORS OF THE TAXONOMIC INDEX

TAXONOMY, PHYLOGENY AND FLORISTICS

ALGAE

Allen, G. O. Notes on Charophytes from British Columbia. Proc. Linn. Soc. London **162**: 148–152. 16 Mr 1951.

Flint, Lewis H. Studies of freshwater red algae. Am. Jour. Bot. **37**: 754–757. N 1950 [Mr 1951].

Horn af Rantzien, Henning. Charophyta reported from Latin America. Ark. Bot. N S **1**: 355–411. 8 Au 1950.

Verduin, Jacob. A comparison of phytoplankton data obtained by a mobile sampling method with those obtained from a single station. Am. Jour. Bot. **38**: 5–11. Ja [Ap 1951].

BRYOPHYTES

Fabius, *Fr.* Quelques mousses rares ou intéressantes récoltées dans les environs de Granby. Nat. Canad. **77**: 313–318. 1950.

Harvill, A. M. The mosses of King Cove, Lawrence County, Alabama. Castanea **16**: 19–22. Mr 1951.

Kucyniak, James. Muscinées nouvelles pour le Quebec; *Calypogeia fissa, Odontoschisma elongatum; Didymodon rufus et Hypnum bembergeri.* Nat. Canad. **77**: 305–312. 1950.

Lawton, Elva. Bryophytes of the Beaver Lake region of New Jersey—a new station for *Pohlia carnea* (L.) Lindb. Bull. Torrey Club **78**: 164. Mr 1951.

Schuster, Rudolf M. Notes on Nearctic Hepaticae III. A conspectus of the family Lophoriziaceae, with a revision of the genera and subgenera. Am. Midl. Nat. **45**: 1–117. Ja [Mr] 1951.

FUNGI

Ames, L. M. New species of cellulose decomposing fungi. III. Mycologia **43**: 29–33. Ja–F 1951.

Bonar, Lee. Two new fungi on *Torreya* [*Caeoma torreya, Clasterosporium obclavatum*, spp. nov.]. Mycologia **43**: 62–66. Ja–F 1951.

Cook, Melville T. Species of *Synchytrium* in Louisiana. VI. Two new species on *Impatiens* and *Smilax*. Mycologia **43**: 103–107. Ja–F 1951.

Cummins, George B. Uredinales of continental China collected by S. Y. Cheo. II. Mycologia **43**: 78–98. Ja–F 1951.

Davis, Eli & Sutton, W. D. Some Myxomycetes of Canada. Canad. Field-Nat. **64**: 180–185. 1950.

Dennis, R. W. G. *Lentinus* in Trinidad, B. W. I. Kew Bull. **1950**: 321–333. [1951].

Fischer, George M. Some new grass smut records from the western states. II. Mycologia **43**: 67–77. Ja–F 1951.

Groves, J. Walton. *Dermatea* vs. *Dermea*. Mycologia **43**: 114. Ja–F 1951.

Jackson, H. S. & Dearden, Elizabeth Ruth. Studies of North American Thelephoraceae. I. Some new western species of *Peniophora*. Mycologia **43**: 54–61. Ja–F 1951.

Johnson, T. & Green, G. J. The varieties of stem rust, *Puccinia graminis* Pers., occurring on barberry in eastern Canada. Canad. Jour. Bot. **29**: 1–9. F 1951.

Johnson, T. W. A new *Mindeniella* from submerged, rosaceous fruits. Am. Jour. Bot. **38**: 74–78. Ja [Ap] 1951.

Mains, E. B. Notes concerning entomogenous fungi. Bull. Torrey Club **78**: 122–133. Mr 1951.

Martin, G. W. The genus *Seismosarca* Cooke. Mycologia **43**: 112, 113. Ja–F 1951.

Mason, Clarence T., Brown, R. W. & Minga, Audrey E. The relationship between fungicidal activity and chemical constitution. Phytopathology **41**: 164–171. F 1951.

Moss, E. H. Rusts on *Adoxa* in Alberta. Mycologia **43**: 99–102. Ja–F 1951.

Olive, Lindsay S. New or noteworthy species of Tremellales from the southern Appalachians. Bull. Torrey Club **78**: 103–112. Mr 1951.

Pady, S. M. Fungi isolated from arctic air in 1947. Canad. Jour. Bot. **29**: 46–56. *pl. 1*. F 1951.

Rogers, Donald P. *Trechispora* and *Pellicularia*. Mycologia **43**: 111. Ja–F 1951.

Savile, D. B. O. *Peronospora stigmaticola* in Canada. Mycologia **43**: 113, 114. Ja–F 1951.

Wehmeyer, Lewis E. Studies in the genus *Pleospora*. III. Mycologia **43**: 34–53. Ja–F 1951.

SPERMATOPHYTES

Amshoff, G. J. H. Notes on Guiana Myrtaceae III. Rec. Trav. Bot. Néerl. **42**: 1–27. D 1951.

Baldwin, J. T. & Speese, Bernice M. Cytogeography of *Clappertonia* in West Africa. Bull. Torrey Club **78**: 161–163. Mr 1951.

Baldwin, J. T. & Speese, Bernice M. *Penthorum*: its chromosomes. Rhodora **53**: 89–91. Mr 1951.

Barrett, Mary F. *Ficus* in Florida—III. Asiatic species. Am. Midl. Nat. **45**: 118–183. Ja [Mr] 1951.

Bean, R. C., Knowlton, C. H. & Hill, A. F. Tenth report of the committee on plant distribution [in New England]. Rhodora **53**: 79–89. Mr 1951.

Blake, S. F. *Tussilago farfara* in Maryland. Rhodora **53**: 93, 94. Mr 1951.

Bravo H., Helia. Iconografia de las Cactáceas Mexicanas (Primera serie) Cactáceas del Norte de Sonora. Anal. Inst. Biol. [Mexico] **21**: 439–482. 1950 [1951].

Bravo H., Helia. Notas cactológicas. Anal. Inst. Biol. [Mexico] **21**: 293–298. 1950 [1951].

Burtt, B. L. *Pernettya prostrata* subsp. *Pentlandii*. Bot. Mag. **167**: *pl. 127*. 29 D 1950.

Camp, Wendell H. A biogeographic and paragenetic analysis of the American beech (*Fagus*). [Preliminary report.] Am. Philos. Soc. Yearbook 1950: 166–169. 1951.

Collins, J. L. Notes on the origin, history, and genetic nature of the Cayenne pineapple. Pacif. Sci. **5**: 3–17. Ja 1951.

Correll, Donovan Stewart. Native orchids of North America north of Mexico. *i–xv* + 1–399. *illus.* Chronica Bot. Co. Waltham, Mass. 1950.

Cuatrecasas, José. Notas a lá flora de Colombia. X. Revista Acad. Colomb. 8[29]: 33–64. *pl. 1–4.* N 1950.

Franco, Jaõa do Amaral. *Cedrus libanensis* et *Pseudotsuga Menziensii.* (Bol.) Soc. Brot. II **24**: 73–77. 1950.

Fries, Rob. E. Three new species of Annonaceae from northern South America. Ark. Bot. N S **1**: 445–451. 21 N 1950.

Gaiser, L. O. Chromosome studies in *Liatris* III. Punctatae. Am. Jour. Bot. **37**: 763–777. N 1950 [Mr 1951].

Hawkes, A. D. Major genera of cultivated orchids. IX-X. Am. Orchid Soc. Bull. **20**: 35, 36; 93, 94. J–F 1951.

Hotchkiss, Neil. Range extensions of marsh and aquatic plants. 2. Rhodora **53**: 91–93. Mr 1951.

Hughes, Ralph H. Observations of cane (*Arundinaria*) flowers, seed, and seedlings in the North Carolina coastal plain. Bull. Torrey Club **78**: 113–121. Mr 1951.

Jenkins, Anna E. *et al.* Peter Wilhelm Lind's pequi tree at Lagoa Santa and pilgrimages to his cemetary. Jour. Wash. Acad. **41**: 66–74. F 1951.

Kobuski, Clarence E. Studies in the Theaceae, XXI. The species of Theaceae indigenous to the United States. Jour. Arnold Arb. **32**: 123–138. 16 Ap 1951. XXII. Some new species of Theaceae in South America. 152–154.

León [*Hermano*] **& Alain** [*Hermano*] Novedades de la flora Cubana (II). Contr. Ocas. Mus. Hist. Nat. Colegio "de la Salle" **9**: 1–24. N 1950.

McDowell, G. W. Three additions to the flora of Georgia from the Blue Ridge Mountains. Castanea **16**: 18. Mr 1951.

Long, F. R. Collecting succulents in South Africa. V. Cactus & Succ. Jour. **22**: 171–173. N–D 1950.

McVaugh, Rogers. Edward Palmer's collection in the Indian Territory 1868. Chron. Okla. **23**: 16–21. 1945.

McVaugh, Rogers. Questionable validity of names published in Gilibert's Floras of Lithuania. Gent. Herb. **8**: 83–90. 14 My 1949.

Mangelsdorf, Paul C. & Oliver, Douglas L. Whence came maize to Asia? Bot. Mus. Leafl. **14**: 263–291. *pl. 48.* 13 Ap. 1951.

Martínez, Maximino. *Euonymus mexicanus* Benth. Anal. Inst. Biol. [Mexico] **21**: 279–284. 1950 [1951].

Martínez, Maximino. *Libocedrus decurrens* Torr. Anal. Inst. Biol. [Mexico] **21**: 285–291. 1950 [1951].

Martínez Crovetto, R. & Piccinini, B. G. La vegetación de la República Argentina. I—Los Palmares de Butia Yatay. Revista Invest. Agr. [Buenos Aires] **4**: 153–242. *pl. 1–10.* Ap 1950.

Matuda, Eizi. Estudio de las plantas de Chiapas. VII. Marantáceas de Chiapas. Anal. Inst. Biol. [Mexico] **21**: 319–343. 1950 [1951].

Merrill, E. D. Notes on *Elaeocarpus.* Jour. Arnold Arb. **32**: 157–200. 16 Ap 1951.

Miranda, Faustino. Algunas novedades de la flora de Chiapas. Anal. Inst. Biol. [Mexico] **21**: 299–308. 1950 [1951].

Miranda, Faustino. *Fouquieria fasciculata* y dos nuevas gamopetalas de México. Anal. Inst. Biol. [Mexico] **21**: 309–317. 1950 [1951].

Neal, Marie C. Common and aberrant flowers of *Cassia fistula.* Pacif. Sci. **5**: 82–89. Ja 1951.

Ownbey, Gerald B. On the cytotaxonomy of the genus *Corydalis*, section *Eucorydalis*. Am. Midl. Nat. **45**: 184–186. Ja [Mr] 1951.

Reed, Clyde F. & Reed, Priscilla G. Host distribution of mistletoe in Kentucky. Castanea **16**: 7–15. Mr 1951.

Reitz, P. Raulino. Bromeliaceas de S. Catarina—II. Anal. Herb. Barbosa Rodrigues **2**: 39–55. 22 Je 1950.

Reitz, P. Raulino. Notas sôbre o gênero *Canistrum* de S. Catarina. Anal. Herb. Barbosa Rodrigues **2**: 35–38. 22 Je 1950.

Reitz, P. Raulino. Plantas medicinais de Santa Catarina. Anal. Herb. Barbosa Rodrigues **2**: 71–116. 22 Je 1950.

Reitz, P. Raulino. Vegetacão do Morro do Baú. Anal. Herb. Barbosa Rodrigues **2**: 57–70. 22 Je 1950.

Ritchie, Don. Late flowering dates of some common plants of Rockland County, New York. Castanea **16**: 16, 17. Mr 1951.

St. John, Harold & Storey, William Bicknell. Diagnoses of new species of *Cyrtandra* (Gesneriaceae) from Oahu, Hawaiian Islands. Hawaiian Plant Studies 20. Occ. Pap. Bishop Mus. **20**: 77–88. 25 Au. 1950.

Scoggan, H. J. The flora of Bic and the Gaspé Peninsula, Quebec. Bull. Nat. Mus. Canada **115**: 1–399. 1950.

Sherff, Earl Edward. Miscellaneous notes on new or otherwise noteworthy dicotyledonous plants. Am. Jour. Bot. **38**: 54–73. Ja [Ap] 1951.

Sherff, Earl Edward. Notes upon certain new or otherwise interesting plants of the Hawaiian Islands and Colombia. Botanical Leaflets **3**: 2–8. 9 Mr 1951.

Simmonds, N. W. The Araceae of Trinidad and Tobago, B. W. I. Kew. Bull. 1950: 391–406. [1951].

Smith, Lyman B. Chaves para as Bromeliáceas de Santa Catarina. Anal. Herb. Barbosa Rodrigues **2**: 17–33. 22 Je 1950.

Smith, Lyman B. Notas sôbre as Bromeliaceás de Santa Catarina. Anal. Herb. Barbosa Rodrigues **2**: 13–15. 22 Je 1950.

Snyder, Leon A. Morphological variability and hybrid development in *Elymus glaucus*. Am. Jour. Bot. **37**: 628–636. O 1950 [F 1951].

Stafleu, F. A. A new *Trigonia* from Suriname. Rec. Trav. Bot. Néerl. **42**: 71. D 1950.

Summerhayes, V. S. New orchids from Africa. Bot. Mus. Leafl. **14**: 215–239. 13 Mr 1951.

Summerhayes, V. S. A revision of the genus *Angraecopsis*. Bot. Mus. Leafl. **14**: 240–261. 13 Mr 1951.

Swart, J. J. A new *Protium* from Suriname. Rec. Trav. Bot. Néerl. **42**: 70. D 1950.

White, C. T. Some noteworthy Myrtaceae from the Moluccas, New Guinea, and the Solomon Islands. Jour. Arnold Arb. **32**: 139–149. *pl. 1*. 16 Ap 1951.

Woodson, Robert E., *et al.* Flora of Panama. Part V. Fascicle 3 (Leguminosae, second part). Ann. Mo. Bot. Gard. **38**: 1–96. F 1951.

ECOLOGY AND PLANT GEOGRAPHY

Braun, E. Lucy. Deciduous forests of eastern North America. *i–xiv* + 1–596. *illus.* Blakiston. Philadelphia. 1950.

Brown, A. W. A. Effect on trees of extremes of climate in southern Alberta. Canad. Field.-Nat. **64**: 185, 186. 1950.

Brumwell, Malcolm J. An ecological survey of the Fort Leavenworth Military Reservation. Am. Midl. Nat. **45**: 187–231. *illust.* Ja [Mr] 1951.

Conard, Henry S. The background of plant ecology. A translation from the German. The plant life of the Danube basin by Anton Kerner (1863). *i–x* + 1–238. Iowa State Coll. Press. Ames, Iowa. 1951.

Coupland, R. T. Ecology of mixed prairie in Canada. Ecol. Monogr. **20**: 271–315. O 1950.

Howard, Richard A. Vegetation of the Bimini Island group, Bahamas, B. W. I. Ecol. Monogr. **20**: 317–349. O 1950.

Little, S. Observations on the minor vegetation of the Pine Barren swamps in southern New Jersey. Bull. Torrey Club **78**: 153–160. Mr 1951.

Quarterman, E. Ecology of cedar glades. III. Corticolous bryophytes. Bryologist **52**: 153–165. 1949.

Rigg, George B. The development of sphagnum bogs in North America. II. Bot. Rev. **17**: 109–131. F 1951.

PALEOBOTANY

Brown, Roland W. Cretaceous plants from southwestern Colorado. U. S. Geol. Surv. Prof. Pap. **221D**: 45–66. 1950.

Miki, Shugeru & Hikita, Shigeru. Probable chromosome number of fossil *Sequoia* and *Metasequoia* found in Japan. Science **113**: 3–6. 5 Ja 1951.

Schemel, Mart P. Cretaceous plant microfossils from Iowa. Am. Jour. Bot. **37**: 750–754. N 1950 [Mr 1951].

Stewart, Wilson N. Report on the Carr and Daniels collections of fossil plants from Mazon Creek. Trans. Ill. Acad. **43**: 41–45. 30 D 1950.

MORPHOLOGY

(including anatomy and cytology in part)

(See also under Spermatophytes: **Hughes**; under Plant Physiology: **Duncan & Ross**)

Allard, H. A. The ratio of clockwise and counterclockwise spirality observed in the phyllotaxy of some wild plants. Castanea **16**: 1–6. Mr 1951.

Bannan, M. W. The reduction of fusiform cambial cells in *Chamaecyparis* and *Thuja*. Canad. Jour. Bot. **29**: 57–67. *3 pl.* F 1951.

Barton, Donald W. Pachytene morphology of the tomato chromosomes complement. Am. Jour. Bot. **37**: 639–643. O 1951 [F 1951].

Brown, Howard S. & Addicott, Frederick T. The anatomy of experimental leaflet abscission in *Phaseolus vulgaris*. Am. Jour. Bot. **37**: 650–656. O 1950 [F 1951].

Dadswell, H. E. & Ingle, H. D. Wood anatomy in the genus *Eucalyptopsis* White. Jour. Arnold Arb. **32**: 150–151. *1 pl.* 16 Ap 1951.

Eames, Arthur J. Destruction of phloem in young bean plants after treatment with 2, 4-D. Am. Jour. Bot. **37**: 840–847. D 1950 [Ap 1951].

Foster, Adriance S. Venation and histology of the leaflets in *Touroulia guianensis* Aubl. and *Froesia tricarpa* Pires. Am. Jour. Bot. **37**: 848–862. D 1950. [Ap 1951].

Gifford, Ernest M. The structure and development of the shoot apex in certain woody Ranales. Am. Jour. Bot. **37**: 595–611. O 1950 [F 1951].

Kaeiser, Margaret. Microscopic anatomy of the wood of three species of junipers. Trans. Ill. Acad. **43**: 46–50. 31 D 1950.

Lewis, Frederic T. Reciprocal cell division in epidermal and subepidermal cells. Am. Jour. Bot. **37**: 715–721. N 1950 [Mr 1951].

Mann, Louis K. & Robinson, Jeanette. Fertilization, seed development, and fruit

growth as related to fruit set in the cantaloupe (*Cucumis melo* L.). Am. Jour. Bot. **37**: 685–697. N 1950 [Mr 1951].

Newcomer, Earl H. Mitochondria in plants. II. Bot. Rev. **17**: 53–89. F 1951.

Olive, Lindsay S. A cytologieal study of ascus development in *Patella melaloma* (Alb. & Schon.) Seaver. Am. Jour. Bot. **37**: 757–763. N 1950 [Mr 1951].

Reeves, R. G. Morphology of the ear and tassel of maize. Am. Jour. Bot. **37**: 697–704. N 1950 [Mr 1951].

Satina, S., Rappaport, J. & Blakeslee, A. F. Ovular tumors connected with incompatible crosses in *Datura*. Am. Jour. Bot. **37**: 576–586. O 1950 [F 1951].

Smith, Ben W. *Arachis hypogaea*. Aerial flower and subterranean fruit. Am. Jour. Bot. **37**: 802–815. D 1950 [Ap 1951].

Steil, W. N. Apogamy, apospory, and parthenogenesis in the Pteridophytes. II. Bot. Rev. **17**: 90–104. F 1951.

Struckmeyer, B. Esther & Riker, A. J. Wound-periderm formation in white pine trees resistant to blister rust. Phytopathology **41**: 276–281. Mr 1951.

Swamy, B. G. L. A contribution to the life history of *Casuarina*. Proc. Am. Acad. **77**: 1–32. *pl. 1–7*. D 1948.

Van Fleet, D. S. A comparison of histochemical and anatomical characteristics of the hypodermis with the endodermis in vascular plants Am. Jour. Bot. **37**: 721–725. N 1950 [Mr 1951].

Wilde, Mary H. Anatomical modifications of bean roots following treatment with 2,4-D. Am. Jour. Bot. **38**: 79–91. Ja [Ap] 1951.

GENETICS

(including cytogenetics)

(See also under Spermatophytes: **Snyder**)

Brown, Meta S. & Menzel, Margaret Y. New trispecies hybrids in cotton. Jour. Hered. **41**: 291–295. N 1950 [Mr 1951].

Gibson, P. B., Brink, R. A. & Stahmann, M. A. The mutagenic action of mustard gas on *Zea mays*. Jour. Hered. **41**: 232–238. S [D] 1950.

Hagberg, Arne & Tedin, Olof. Inter- and intraclonal crosses and inbreeding in potatoes. Hereditas **37**: 280–287. 10 F 1951.

Holton, C. S. & Lowther, C. V. Heritability of number of primary sporidia produced by spores of *Tilletia caries* and *T. foetida*. Phytopathology **41**: 172–177. F 1951.

Hyde, Beal. *Forsythia* polyploids. Jour. Arnold Arb. **32**: 155, 156. *1 pl.* 16 Ap 1951.

Müntzing, Arne. Cyto-genetic properties and practical value of tetraploid rye. Hereditas **37**: 17–84. 10 F 1951.

Routien, John B. Studies on monosporous cultures of *Polyporus cinnabarinus* Fr. Bull. Torrey Club **78**: 145–152. Mr 1951.

Schuldt, Erich & Gottlieb, David. Colchicine as a mutagenic agent for *Streptomyces griseus*. Trans. Ill. Acad. **43**: 51, 52. 31 D 1950.

Sparrow, Rhoda C. & Sparrow, A. H. Spontaneous chromosome fragmentation in *Trillium erectum* L. Am. Nat. **84**: 477–488. D 1950.

Struble, F. Ben & Keitt, G. W. Variability and inheritance in *Glomerella cingulata* (Stonem.) S. and V. S. from apple. Am. Jour. Bot. **37**: 563–576. O 1950 [F 1951].

Thomas, H. Rex, Zaumeyer, W. J. & Jorgensen, Hans. Inhertitance of resistance to Lima-bean mosaic virus in the Lima bean. Phytopathology **41**: 231–234. Mr 1951.

Wellensiek, S. J. New linkage in *Pisum*, Cr-Gp and B-L. Genetica **25**: 183–187. 1950.

Wilson, G. B. Cytological effects [on *Allium*] of some antibiotics. Jour. Hered. **41**: 227–231. S [D] 1950.

PLANT PHYSIOLOGY

(See also under Morphology: Wilde)

Akamine, Ernest K. Viability of Hawaiian forest tree seeds in storage at various temperatures and relative humidities. Pacific Sci. **5**: 36–46. Ja 1951.

Duncan, Robert E. & Ross, James G. The nucleus in differentiation and development. III. Nuclei of maize endosperm. Jour. Hered. **41**: 259–268. O 1950 [Ja 1951].

Dyar, M. T. Some observations on starch synthesis in pea root tips. Am. Jour. Bot. **37**: 786–792. D 1950 [AP 1951].

Erickson, Louis C. & Price, Charles. Some effects of maleic hydrazide on sugar beet plants. Am. Jour. Bot. **37**: 657–659. D 1950 [F 1951].

Gerloff, Gerald C., Fitzgerald, George P. & Skoog, Folke. The mineral nutrition of *Coccochloris peniocystis*. Am. Jour. Bot. **37**: 835–840. D 1950 [4 Ap 1951].

Hartman, Richard T. & Price, W. C. Synergistic effect of plant growth substances and southern bean mosaic virus. Am. Jour. Bot. **37**: 820–828. D 1950 [Ap 1951].

Haskins, R. H. & Weston, Wm. H. Studies in the lower Chytridiales. I. Factors affecting pigmentation, growth, and metabolism of a strain of *Karlingia* (Rhizophlyctis) Rosea. Am. Jour. Bot. **37**: 739–750. N 1950 [Mr 1951].

Hubbard, C. V. & Thornberry, H. H. Utilization of some organic acids by *Streptomyces griseus* for streptomycin production and growth. Trans. Ill. Acad. **43**: 61–74. 31 D 1950.

Kater, J. McA. Amitosis. II. Bot. Rev. **17**: 105–108. F 1951.

Krotkov, G, Wilson, D. G. & Street, R. W. Acid metabolism on McIntosh apples during their development on the tree and in cold storage. Canad. Jour. Bot. **29**: 79–90. F 1951.

McIlrath, Wayne J. Response of the cotton plant to maleic hydrazide. Am. Jour. Bot. **37**: 816–819. D 1950 [Ap 1951].

McVeigh, Ilda & Bell, Emily. The amino acid and vitamin requirements of *Candida albicans* Y-475 and *Mycoderma vini* Y-939. Bull. Torrey Club **78**: 134–144. Mr 1951.

Miller, J. J., Peers, D. J. & Neal, R. W. A comparison of the effects of several concentrations of oxgall in plantings of soil fungi. Canad. Jour. Bot. **29**: 26–31. *pl. 1*. F 1951.

Nason, Alvin. The distribution and biosynthesis of niacin in germinating corn. Am. Jour. Bot. **37**: 612–623. O 1950 [F 1951].

Neish, A. C. Carbohydrate nutrition of *Chlorella vulgaris*. Canad. Jour. Bot. **29**: 68–78. F 1951.

Nickell, Louis G. Effect of certain plant hormones and colchicine on the growth and respiration of virus tumor tissue from *Rumex acetosa*. Am. Jour. Bot. **37**: 829–835. D 1950 [Ap 1951].

Northen, Henry T. Alterations in the structural viscosity of protoplasm by colchicine and their relationship to C-mitosis and C-tumor formation. Am. Jour. Bot. **37**: 705–711. N 1950 [22 Mr 1951].

Rappaport, J., Satina, S. & Blakeslee, A. F. Extracts of ovular tumors and their

inhibition of embryo growth in *Datura*. Am. Jour. Bot. **37**: 586–595. O 1950 [F 1951].

Reese, Elwyn T. & Downing, Mary H. Activity of the *Aspergilli* on cellulose, cellulose derivatives, and wool. Mycologia **43**: 16–28. Ja–F 1951.

Rich, Saul & Horsfall, James G. Gaseous toxicants from organic sulfur compounds. Am. Jour. Bot. **37**: 643–650. O 1950 [F 1951].

Robbins, William J. & McVeigh, Ilda. Observations on the inhibitory action of hydrolyzed agar. Mycologia **43**: 11–15. Ja–F 1951.

Roberts, D. W. A. Some effects of ethylene on germinating wheat. Canad. Jour. Bot. **29**: 10–25. F 1951.

Steinberg, Robert A. Growth on synthetic nutrient solutions of some fungi pathogenic to tobacco. Am. Jour. Bot. **37**: 711–714. N 1950 [22 Mr 1951].

Takahashi, William N. Ultraviolet absorption as a measure of tobacco-virus nucleoprotein. Phytopathology **41**: 142–145. F 1951.

Weaver, E. A. & Cordon, T. C. Increasing potencies of enzymes produced by *Aspergillus niger*. Mycologia **43**: 5–10. Ja–F 1951.

Weissman, Gerard S. Growth and nitrogen absorption of wheat seedlings as influenced by the ammonium nitrate ratio and the hydrogen-ion concentration. Am. Jour. Bot. **37**: 725–738. N 1950 [22 Mr 1951].

Yarbrough, John A. *Arachis hypogaea*. Seedling growth rate. Am. Jour. Bot. **37**: 779–785. D 1950 [Ap 1951].

Yarwood, C. E. Water content of fungus spores. Am. Jour. Bot. **37**: 636–639. O 1950 [F 1951].

PHYTOPATHOLOGY

(See also under Morphology: **Struckmeyer & Riker**; under Genetics: **Thomas, Zaumeyer & Jorgensen**; under Plant Physiology: **Hartman & Price**)

Atkins, J. G. *Helminthosporium victoriae* as a leaf-spotting pathogen on oats in Louisiana. Phytopathology **41**: 300, 301. Mr 1951.

Black, L. M. Further studies on the properties of potato yellow-dwarf virus. Phytopathology **41**: 213–220. Mr 1951.

Bruehl, George W. *Rhizoctonia solani* in relation to cereal crown and root rots. Phytopathology **41**: 375–377. Ap 1951.

Buchanan, Thomas S., Harvey, George M. & Welch, D. S. Pole blight of western white pine: A numerical evaluation of the symptoms. Phytopathology **41**: 199–208. Mr 1951.

Chessin, Meyer. The effects of nitrogen deficiency on the properties of tobacco-mosaic virus. Phytopathology **41**: 235–237. Mr 1951.

Cooley, J. S. Control of white root rot with chloropicrin in a border of ornamental plants. Phytopathology **41**: 379, 380. Ap 1951.

Cormack, M. W. Variation in the cultural characteristics and pathogenicity of *Fusarium avenaceum* and *F. arthrosporioides*. Canad. Jour. Bot. **29**: 32–45. F 1951.

Costa, A. S. & Grant, T. J. Studies on transmission of the tristeza virus by the vector, *Aphis citricidus*. Phytopathology **41**: 105–113. F 1951.

Dimock, A. W. The dispersal of viable fungus spores by insecticides. Phytopathology **41**: 152–156. F 1951.

Dimock, A. W. The dispersal of viable spores of phytopathogenic fungi by fungicidal sprays. Phytopathology **41**: 157–163. F 1951.

Epps, W. M., Patterson, J. C. & Freeman, I. E. Physiology and parasitism of *Sclerotium rolfsii*. Phytopathology **41**: 245–256. Mr 1951.

Frazier, Norman W. Red leaf, an aphid-borne virus disease of filaree. Phytopathology **41**: 221–227. Mr 1951.

Gäumann, Ernst. Principles of plant infections. A text-book of general plant pathology for biologists, agriculturists, foresters and plant breeders. *i–xvi*, 1–543. *illus.* New York, Harper Pub. Co. 1950.

Gerdemann, J. W., & Finley, Arthur M. The pathogenicity of races 1 and 2 of *Fusarium pyxosporum* f. *lycopersici*. Phytopathology **41**: 238–244. Mr 1951.

Grant, Theodore J. & Costa, A. S. A mild strain of the tristeza virus of citrus. Phytopathology **41**: 114–122. F 1951.

Hollis, John P. Bacteria in healthy potato tissue. Phytopathology **41**: 350–366. Ap 1951.

Holmes, Francis O. Indications of a New World origin of tobacco-mosaic virus. Phytopathology **41**: 341–349. Ap 1951.

Liming, O. N., Rex, Edgar O. & Layton, Kenneth. Effects of a source of heavy infection on the development of Dutch elm disease in a community. Phytopathology **41**: 145–151. F 1951.

McWhorter, Frank P. Suggestions for transferring virus from local lesions to test plants. Phytopathology **41**: 185. F 1951.

Martin, W. J. & Person, L. H. Surface rot of Porto Rican sweet potatoes. Phytopathology **41**: 228–230. Mr 1951.

Murakishi, Harry H. Purple seed stain of soybean. Phytopathology **41**: 305–318. Ap 1951.

Nelson, K. E. Factors influencing the infection of table grapes by *Botrytis cinerea* (Pers.). Phytopathology **41**: 319–326. Ap 1951.

Pontis, Rafael E. A canker disease of the coffee tree in Colombia and Venezuela. Phytopathology **41**: 178–184. F 1951.

Popp, W. Infection in seeds and seedlings of wheat and barley in relation to development of loose smut. Phytopathology **41**: 261–275. Mr 1951.

Porter, R. Howard. Treatment of crop seeds in Brazil and Paraguay. Phytopathology **41**: 367–374. Ap 1951.

Pound, Glenn S. Effect of air temperature on incidence and development of the early blight disease of tomato. Phytopathology **41**: 127–135. F 1951.

Rumley, Gail E. & Thomas, W. D. The inactivation of the carnation-mosaic virus. Phytopathology **41**: 301–303. Mr 1951.

Sherbakoff, C. D. A correction of the identification of *Helminthosporium* causing black ear rot of corn. Phytopathology **41**: 378. Ap 1951.

Smith, Floyd F. & Brierley, Philip. Aster yellows in canna. Phytopathology **41**: 190, 191. F 1951.

Smith, Oliver F. Biological races of *Ditylenchus dipsaci* on alfalfa. Phytopathology **41**: 189, 190. F 1951.

Smith, Paul G. & Gardner, M. W. Resistance in tomato to the spotted-wilt virus. Phytopathology **41**: 257–260. Mr 1951.

Spencer, J. L. & White, H. E. Anther smut of carnation. Phytopathology **41**: 291–299. Mr 1951.

Stoddard, E. M. & Dimond, A. E. The chemotherapeutic control of *Fusarium* wilt of carnation. Phytopathology **41**: 337–340. Ap 1951.

Stoner, Warren H. An aphid-transmitted virus disease of Fuller's teasel and pincushion flower. Phytopathology **41**: 191–194. F 1951.

Tapke, V. F. New physiologic races of *Ustilago nigra* from the United States and Israel. Phytopathology **41**: 139–141. F 1951.

Theis, T. N., Riker, A. J. & Allen, O. N. The destruction of crown-gall bacteria in periwinkle by high temperature with high humidity. Am. Jour. Bot. **37**: 792–801. D 1950 [Ap 1951].

Timnick, Margaret Barton, Lilly, Virgil Greene & Barnett, H. L. Factors affecting sporulation of *Diaporthe phaseolorum* var. *batatatis* from soybean. Phytopathology **41**: 327–336. Ap 1951.

Valleau, W. D. Tobacco ring-spot virus: the cause of eggplant yellows Phytopathology **41**: 209–212. Mr 1951.

Welsh, Maurice T. & Wilks, Jack M. Induced modification of symptom severity in little cherry. Phytopathology **41**: 136–138. F 1951.

Yarwood, C. E. Defoliation by a rain-favored, a dew-favored, and a shade-favored disease. Phytopathology **41**: 194, 195. F 1951.

GENERAL BOTANY

Archer, W. Andrew. New plastic aid in mounting herbarium specimens. Rhodora **52**: 298, 299. D 1950 [3 Ja 1951].

Bartlett, Harley Harris. Fernald as a reviser of Gray's Manual. Rhodora **53**: 44–55. 26 F 1951.

Feldmann, Jean. René Marie (1878–1949). Revue Gén. Bot. **68**: 65–88. *port.* F 1951.

Fogg, John M. Fernald as a teacher. Rhodora **53**: 39–43. 26 F 1951.

Griscom, Ludlów. Fernald in the field. Rhodora **53**: 61–65. 26 F 1951.

Le Gallo, *Père* C. Le père Théophile Klaine. Nat. Canad. **77**: 318–333. 1950. [Ja 1951].

Pease, Arthur Stanley. Merritt Lyndon Fernald 1873–1950. Rhodora **53**: 33–39. 26 F 1951.

Rollins, Reed C. Deep-freezing flowers for laboratory instruction in systematic botany. Rhodora **52**: 289–297. D 1950 [3 Ja 1951].

Rollins, Reed C. Fernald as a botanist. Rhodora **53**: 56–61. 26 F 1951.

Schultes, Richard Evans. Oakes Ames, 1874–1950. Rhodora **53**: 67–78. *port.* Mr 1951.

Skottsberg, C. Pehr Kalm. Sv. Vet.-Akad. Årsbok **1950**: 279–365. 1950.

Small, J. A. Oakes Ames, Sept. 26, 1874–April 28, 1950. Bull. Torrey Club **78**: 164, 165. Mr 1951.

Stevenson, John A. George Lorenzo Zundel. Mycologia **43**: 1–4. *port.* Ja–F 1951.

Vicitez, Ernesto. Palynological observations on some Spanish honeys. Bull. Torrey Club **77**: 494–502. 22 D 1950.